part6

Table 5-11 shows appliance disposition based on participant survey responses. Table 5-12 shows the same calculation for freezers.

Table 5-11: Refrigerator Discard/Keep Distribution

Discard/Keep	*Proportion of Participant Sample (n = 74)*	*Discard Scenario*	*Proportion of Discards (n=54)*	*Overall Proportion*
Discard	73%	Transfer	41%	30%
		Destroy	59%	43%
Keep	27%			27%

Table 5-12: Freezer Discard/Keep Distribution

Discard/Keep	*Proportion of Participant Sample (n = 27)*	*Discard Scenario*	*Proportion of Discards (n=15)*	*Overall Proportion*
Discard	56%	Transfer	47%	25.9%
		Destroy	53%	29.6%
Keep	44%			44.4%

Secondary market impacts account for program effects on would-be acquirers of program units (since they are no longer available to acquire program units). Only units that would have been transferred absent the program are considered in the secondary market impact analysis. As detailed in Section 5.2.1.5, a midpoint approach is taken in this evaluation, based on the recommendation of the UMP protocols. That is, 50% of would-be acquirers of program avoided transfers are assumed to find an alternate unit. Of those who are assumed to find an alternative unit, 50% are assumed to find a similar used unit, while 50% are assumed to purchase a new unit.

Induced replacement refers to a scenario in which the RARP causes a program participant to purchase a replacement appliance. That is, the participant would not have replaced the refrigerator or freezer in the absence of the program. Participant survey respondents were asked a series of questions to determine whether replacement was induced. The final induced replacement estimates are shown in Table 5-13.

Table 5-13: Induced Replacement Rate by Measure

Measure	*Induced Replacement Rate*
Refrigerator (n=71)	2.82%
Freezer (n=30)	10.00%

The Evaluation Team determined net savings as UMP gross savings less free-ridership, secondary market impacts, and including induced replacement. Figure 5-4 depicts the complete net-to-gross ratio calculation for refrigerators. Figure 5-5 shows the same calculation for freezers.

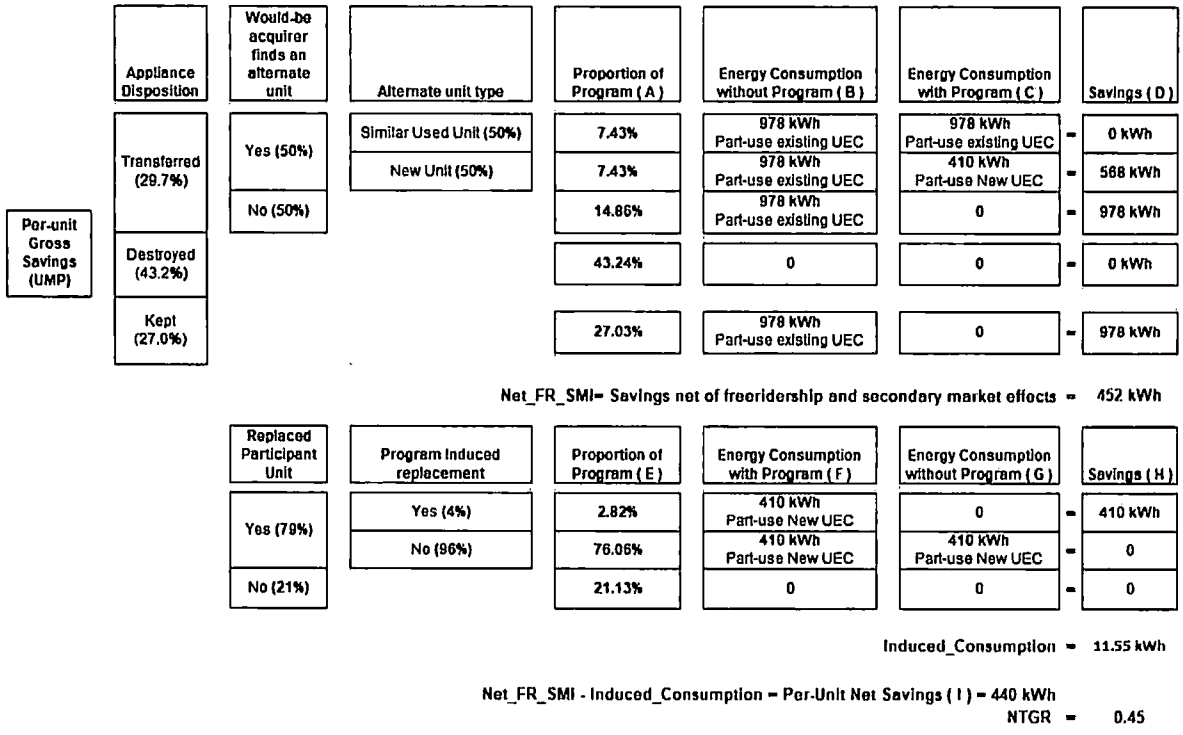

Figure 5-4: NTGR Calculation – Refrigerators

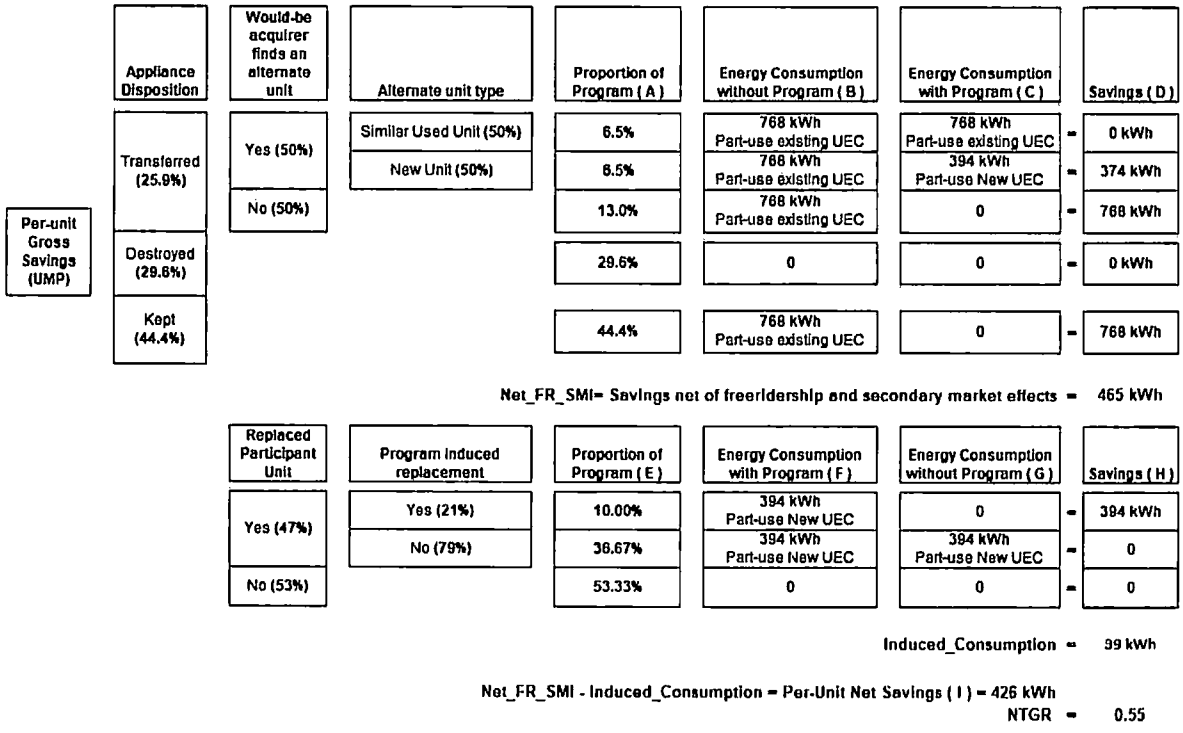

Figure 5-5: NTGR Calculation – Freezers

Table 5-14 summarizes per-unit net annual energy savings for refrigerators and freezers.

Table 5-14: Per-unit Net Annual Energy Savings (kWh)

Measure	*Per-unit Gross Savings (UMP)*	*NTGR*	*Per-unit Net Savings*
Refrigerators	978	45%	440
Freezers	768	55%	426

Per-unit net peak demand reduction is calculated by multiplying the measure specific net-to-gross ratio estimates by gross savings, as shown in Table 5-15.

Table 5-15: Per-unit Net Peak Demand Reduction (kW)

Measure	*Per-unit Gross Peak Demand Reduction (kW)*	*NTGR*	*Per-unit Gross Peak Demand Reduction (kW)*
Refrigerator	0.12	45%	0.05
Freezer	0.09	55%	0.05

Based on the survey responses for the 74 refrigerators and 30 freezers (eligible participants in calculating NTGR), the Evaluation Team estimated NTGR of 45% for refrigerators and 55% for freezers. This value was multiplied by gross per-unit kWh. These values were applied in discounting gross annual kWh and peak demand savings to determine net savings for the 2017 RARP.

5.3 Process Evaluation

The following section presents key findings from the process evaluation conducted for the 2017 Residential Appliance Recycling Program. This evaluation is based upon analysis of surveys of participating customers, and a review of program tracking data, and interviews with program staff from ARCA and the Company.

5.3.1 Summary of Primary Data Collection

- Review of program documentation and relevant literature: The Evaluation Team reviewed relevant program documents, reports, and other materials to gain an understanding of program operation and structure. Documents reviewed included the program website and program tracking data.
- Participant surveys: Participant surveys were the primary data source for understanding the customer perspective on the program and evaluating participant satisfaction. The participant

surveys provided customer feedback and insight regarding customer experiences with the Appliance Recycling Program. Respondents reported on their satisfaction with the program, characteristics of the appliance they recycled, characteristics of the replacement unit (if applicable), and the ease of signing up and having the unit recycled. One primary purpose of the participant survey was to gather information that would inform the savings impact evaluation; this methodology is further detailed in the Gross Savings chapter of this report.

- Interviews with program staff members: Interviews with program management staff from ARCA and the Company were conducted to provide information regarding program design, performance thus far, and comparisons to similar appliance recycling programs operated in other service territories.

5.3.2 Overview of the Program Process

The Company's RARP is designed to reduce energy consumption by removing appliances from customers' homes and recycling them in an environmentally responsible way. The RARP provides customers both convenience and financial incentives to encourage them to recycle refrigerators and freezers. The convenience the program offers is a service whereby the program will pick up the customer's appliances from their residence at no charge.

Financial incentives are provided in the form of a $50 per unit rebate for disposing of a working appliance through the program. Furthermore, the program stresses the larger economic benefit from the energy savings resulting from disposing of an older model refrigerator or freezer.

Customers can participate in the program either by signing up directly using a toll-free number or online. To participate in the Appliance Recycling Program, potential participants must receive electric service through the Company and have an active residential utility account. Units are eligible for recycling if they are between 10 and 30 cubic feet in size, are at least 10 years old, and are in working condition at the time of pickup. Customers are allowed to recycle a maximum of two units per year.

5.3.3 Appliance Recycling Program Participation

According to the program database, a total of 1,392 appliances were recycled during PY2017. Of these, as the following figure shows, refrigerators accounted for nearly three-quarters of the recycled appliances (72%) while freezers accounted for the remainder (28%).

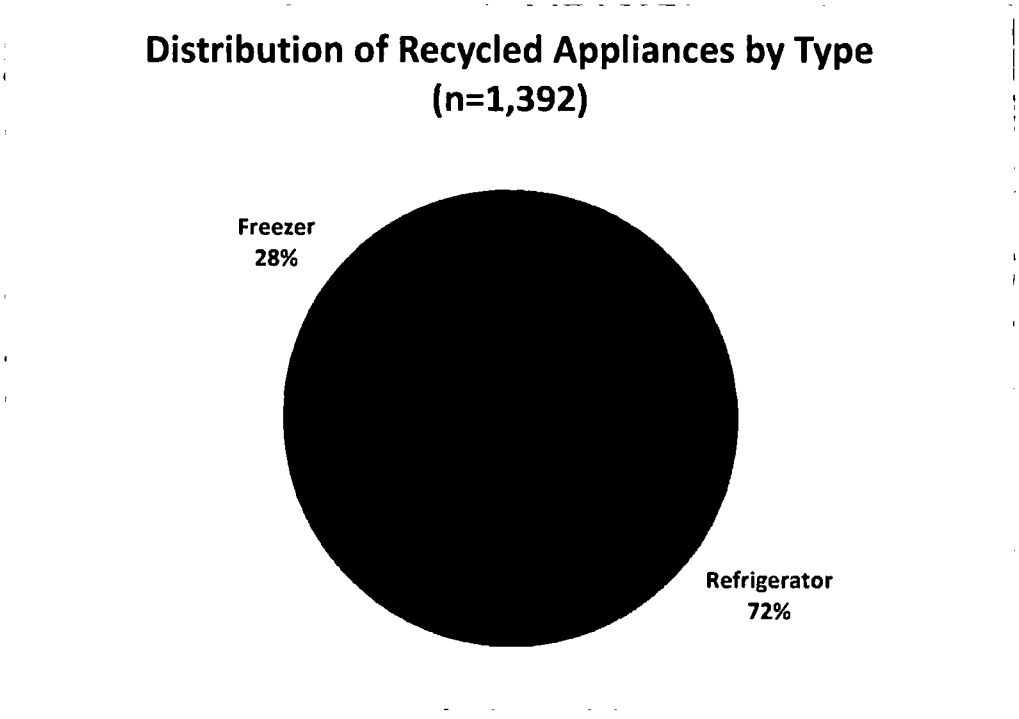

Figure 5-6 Distribution of Recycled Appliances by Type

The program has also been effective in targeting older, inefficient appliances, as the average age for the recycled units exceeds 20 years as Table 5-16 shows.

Table 5-16 Average Age of Recycled Appliances

Type of Appliance	*Average Age*
Refrigerator	21.27
Freezer	26.06

Program participation peaked in December, with a pick-up of 233 units. Overall, it varied from a low of 50 units per month in April and August compared to periods of higher activity in September.

Appliances were also picked up in a timely manner, with 43% of the customers receiving a pick up within 21 days of the scheduled appointment. Only 4% of the customers had to wait more than 50 days for a scheduled pick up.

Table 5-17 Number of Pick Ups by Month

Month	*# Picked Up*
January	133
February	72

Month	*# Picked Up*
March	68
April	50
May	125
June	66
July	65
August	50
September	225
October	182
November	123
December	233
Total	1,392

The difference between order and pickup date can be a function of multiple factors. These include fluctuations in program demand, challenges faced by the customer in finding a time they are unavailable, or rescheduling of orders.

Table 5-18 Analysis of Order Processing Times

Number of Days from Order to Pick Up	*% of Total*	*% of Total*
Less than 10 Days	366	26%
10-21 days	599	43%
22-50 days	374	27%
>50 Days	53	4%
Total	1,392	100%

Table-5-19 Cities with the Highest Participation Rates

City	*# of Units*	*% of Total*
Roanoke	319	23%
Lynchburg	121	9%
Blacksburg	57	4%
Vinton	40	3%
Forest	38	3%
Christiansburg	37	3%
Galax	32	2%
Abingdon	31	2%
Madison Heights	24	2%
Pulaski	24	2%

In contrast, the following cities reported the lowest level of activity in the program. None of these cities reported more than one scheduled pick up during PY2017.

Table 5-20 Cities with the Lowest Participation Rates

City	*# of Units*	*% of Total*
Nora	1	<1%
Parrott	1	<1%
Patrick Springs	1	<1%
Pound	1	<1%
Rich Creek	1	<1%
Rosedale	1	<1%
Roseland	1	<1%
Swords Creek	1	<1%
Troutdale	1	<1%

5.3.4 Participant Survey Findings

The Evaluation Team conducted surveys with program participants as part of the evaluation effort for the 2017 RARP. These surveys were designed to gather information related to both the impact and process components of the program evaluation. Data collected via participant surveying is used in evaluating:

- Sources of program awareness;
- Customer decision-making characteristics;[39]
- Characteristics and usage of the recycled appliance;[40]
- Customer experiences with the program sign-up and appliance pick-up process; and
- Customer satisfaction with the program.

In total, 101 customer participants who recycled at least one appliance through the program responded to the survey. This section highlights the findings from this survey effort, focusing on the qualitative data provided about the program experience. The results for questions that are used to inform the program savings impacts analysis are described in detail in the Gross Savings and Net Savings Methodology Chapters of this report.

5.3.4.1 Customer Awareness of the Program

Participants were first asked how they first learned about the Appliance Recycling program. As shown in Figure 5-7, respondents most commonly reported that they heard about the program through bill inserts (25%). Other common sources of program information came from emails sent by the Company (15%)[41] as well as word-of-mouth (14%).

[39] Decision-making characteristics are used to inform the net-to-gross estimation process. Further details regarding this process can be found in the Net Savings chapter of this report.

[40] Recycled appliance characteristics are used to inform the gross savings analysis. Further details regarding this process can be found in the Gross Savings chapter of this report.

[41] This was not a survey response option but was commonly provided through open-ended responses.

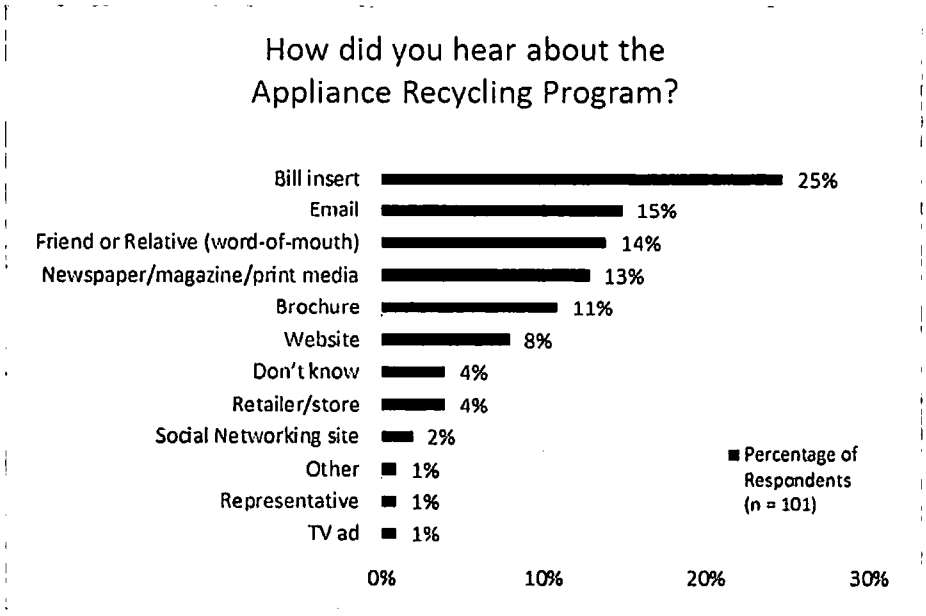

Figure 5-7 How Customers Initially Learned about the Program

5.3.4.2 Customer Decision Making Characteristics

To understand customer values and potential motivations for participating in the program, survey respondents were asked to identify the main reason they decided to dispose of their appliance through the Company's Appliance Recycling Program. Their responses are categorized based on the type of appliance(s) that they recycled through the program (i.e. refrigerators or freezers). Figure 5-8 displays the percent distribution of responses between participants that have recycled at least one refrigerator, participants that have recycled at least one freezer, and all participants that have recycled at least one appliance through the program.

As shown in Figure 5-8, the distribution of responses for each group are similar overall. All groups most commonly reported that they chose to dispose of their appliance through the Appliance Recycling Program because of the incentive payment (39-47%), followed by the impression that the program was simply a convenient means of disposal for their appliance (16-27%).[42]

Among the respondents that had recycled at least one refrigerator, 11% provided responses that were classified as "other", in contrast to the 3% of respondents, that had recycled at least one freezer, whose responses were also classified as "other". Altogether these respondents mostly

[42] Note that in this figure and others that follow, some respondents provided responses related to the recycling of a refrigerator and a freezer. As a result, the number of responses exceeds the number of survey respondents.

provided responses implying that they simply wanted to upgrade from their old unit. Overall, slightly less than half of respondents from all three groups (43-45%) specifically cited non-financial reasons for recycling their appliance through the Company's program.

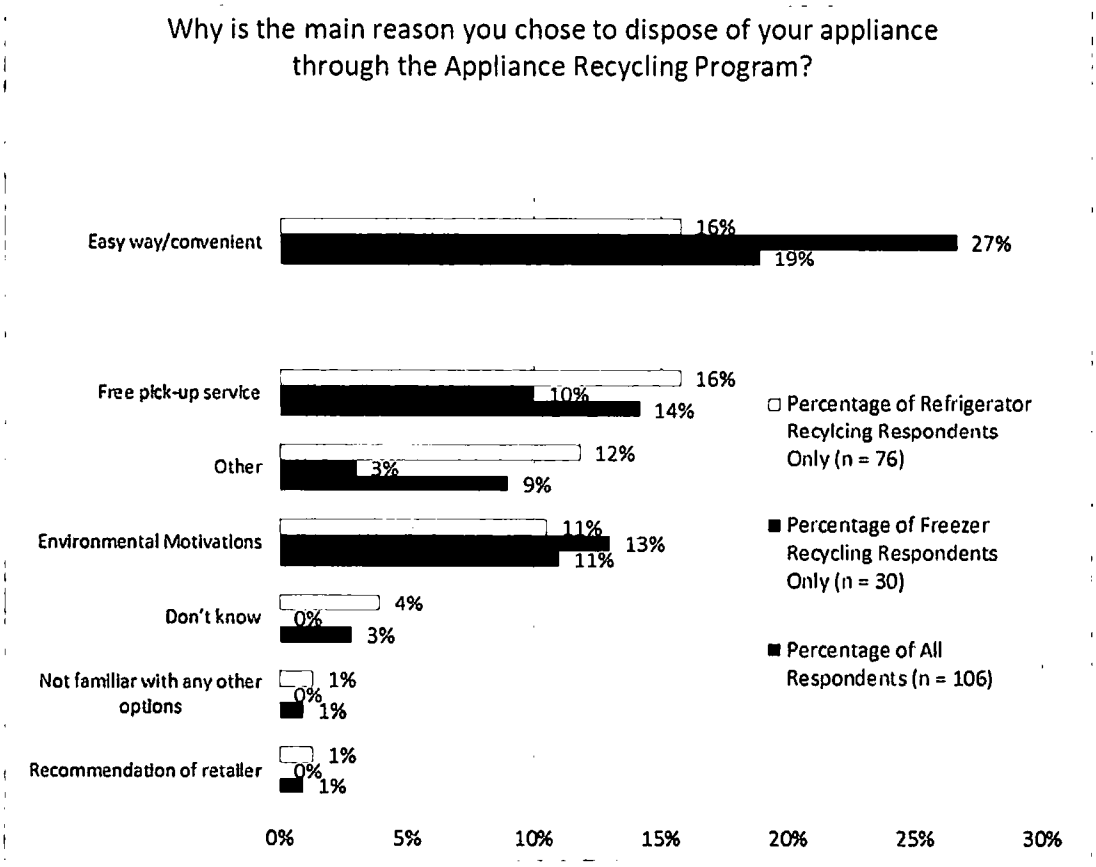

Figure 5-8 Main Reasons for Program Participation

To further gauge the importance of the program rebate, respondents were then asked whether they felt that the amount of the rebate or the convenience of the pick-up was the more important factor in their decision to participate in the program. As shown in Figure 5-9, most respondents (63-67%) stated that the factors were equally important. Twenty-seven to thirty percent stated that the convenience of the pick-up was more important. This supports the idea that the majority of customers typically value the convenience of appliance pick-up at least as much as they value the financial incentive.[43]

[43] This does not suggest that the program would be successful without offering a financial incentive. It is unclear how many customers would participate in the program without an incentive and a substantial portion have reported that they would not participate without the possibility of an incentive.

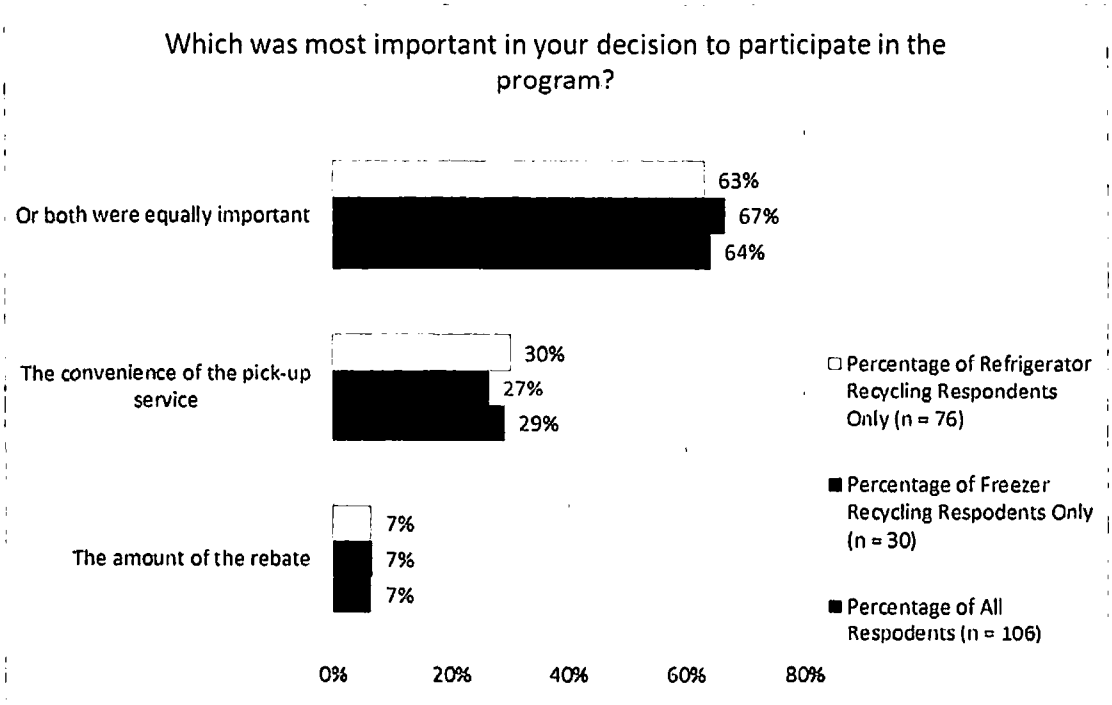

Figure 5-9 Customer Reported Participation with Reduced Rebate Amount

Respondents were asked a series of questions related to their plans and potential actions they might have taken in the absence of the Appliance Recycling Program. As shown in Figure 5-10, 57% of customers who recycled a freezer and 84% of respondents who recycled a freezer reported that they had already considered disposing of the unit before learning of the program.[44]

[44] It is unclear whether these customers had made specific plans to recycle their appliances, and whether they would have proceeded to dispose of the units if the program had not been available.

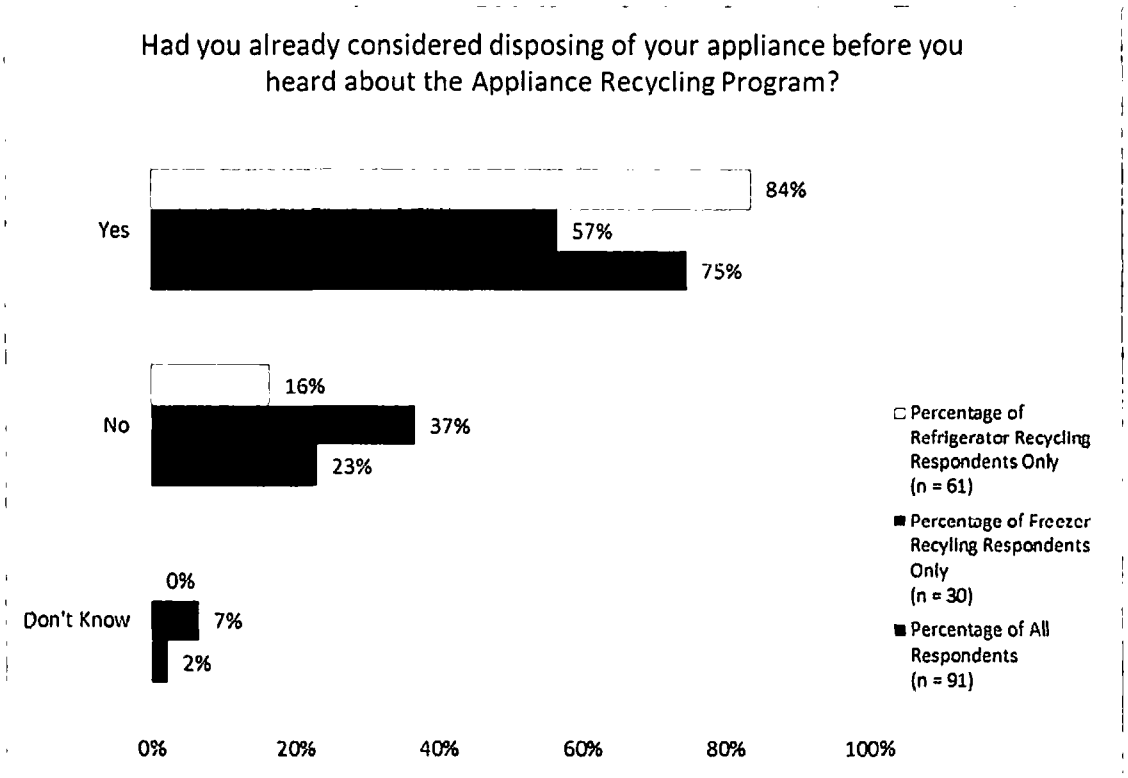

Figure 5-10 Prior Plans to Dispose of Recycled Appliances

Respondents were then asked what they likely would have done with their refrigerator or freezer if they had not disposed of it through the Company's program. Figure 5-11 presents these reported alternative actions. The most commonly reported alternative action was to take the appliance to a dump or recycling center (reported by 23-29% of respondents). Overall, approximately 40% of all respondents referred to an alternative action that would have resulted in the appliance being removed from the electrical grid.

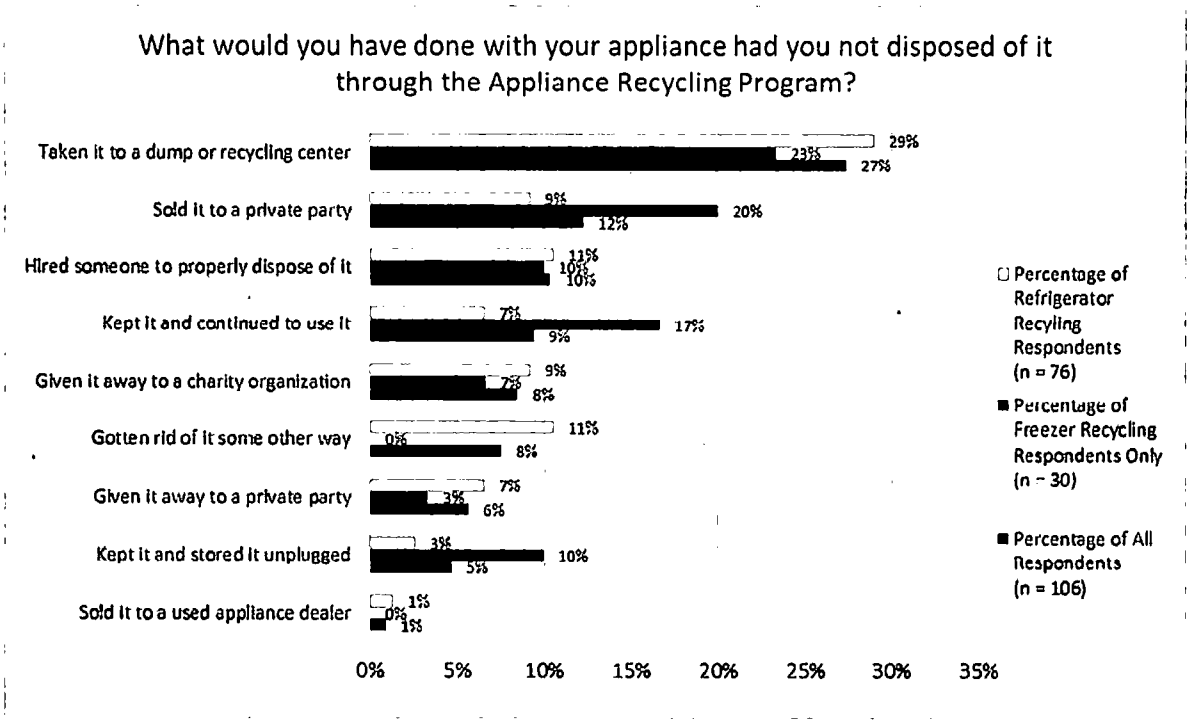

Figure 5-11 Customer Reported Actions in Absence of Program Participation

5.3.4.3 Appliance Pick-up Process

Respondents provided information regarding the actual pick-up process of their appliance. First, all respondents were asked if they had had any interaction with the person that collected their appliance. Sixty percent of all respondents said that they interacted with the person who picked up their appliance. Of these participants, 100% said that the person who collected their appliance was courteous and professional. Respondents were then asked whether the unit was plugged in at the time of pick-up; 79% of respondents indicated that the appliance was plugged in. Following this, respondents were asked whether the pick-up staff verified that the appliance was in working condition; 79% of respondents indicated that this had been done. Their responses to this question are displayed in Table 5-21.

Table 5-21 Verification of Appliance Functionality by Pick-up Crew

Did the person who collected the recycled appliance check to see that [it/they] still worked?	*Response*	*Percent of Respondents (N=61)*
	Yes	79%
	No	11%
	Don't know	10%

Finally, 25% of respondents indicated that the appliance pick-up staff did not permanently disable the unit at the time of pick-up, as shown in Table 5-22. However, it is unclear whether some units are not being disabled, or whether some respondents do not notice the pick-up crew disabling the appliance; the latter scenario may be the case as most respondents cited that they didn't know whether their recycled appliance was permanently disabled or not (48%).

Table 5-22 Disabling of Appliance by Pick-up Crew

Did the person who collected the recycled appliance cut the cord on it or otherwise permanently disable it at the time of pick up?	*Response*	*Percent of Respondents (N=61)*
	Yes	28%
	No	25%
	Don't know	48%

These results suggest that the ARCA pick-up staff members may not be consistently verifying appliance functionality and disabling appliances on-site. However, it is also likely that some respondents did not notice these procedures occurring, even when they did.

5.3.4.4 Customer Satisfaction

The participant survey also asked customers about their satisfaction with several elements of the program. These elements included:

- Satisfaction with the rebate amount;
- Satisfaction with the time it took to receive the rebate;
- Satisfaction with the scheduling of the appliance pick-up;
- Satisfaction with the pick-up process;
- Satisfaction with observed savings on the energy bill; and
- Satisfaction with the overall process of participating in the program.

Respondents were asked about their levels of satisfaction with these program elements; with the response options of "very satisfied", "somewhat satisfied", "neither satisfied nor dissatisfied,"

"somewhat dissatisfied", and "very dissatisfied". Table 5-23 displays the reported satisfaction ratings for each selected program element. Satisfaction ratings were very high for each program element, and the instances of dissatisfaction were fairly infrequent.

Few respondents indicated any dissatisfaction, but 2% said that they were somewhat or very dissatisfied with the scheduling of the pick-up process, and 1% were somewhat dissatisfied with the rebate amount. When asked to elaborate on their reasons for dissatisfaction, two respondents both stated that they had a difficult time scheduling their pick-up and had to reschedule it several times.

Table 5-23 Participant Satisfaction with Selected Elements of Program Experience

Program Element	*Satisfaction Rating*						*N*	*Overall % Satisfied*	*Overall % Dissatisfied*
	Very satisfied	*Somewhat satisfied*	*Neutral*	*Somewhat dissatisfied*	*Very dissatisfied*	*Don't know*			
Rebate amount	75%	21%	1%	1%	0%	0%	101	96%	1%
Time taken to receive rebate	81%	16%	1%	0%	0%	0%	69	97%	0%
Scheduling appliance pick-up	77%	17%	1%	1%	1%	0%	101	94%	2%
Actual appliance pick-up	86%	11%	0%	0%	0%	0%	100	97%	0%
Electric bill savings	77%	20%	0%	0%	0%	1%	30	97%	0%
Overall program satisfaction	89%	8%	0%	0%	0%	2%	100	97%	0%

Some respondents provided open-ended commentary related to their overall satisfaction with the program. Specific commentary included:

> *"Good program. [I am] happy that it was an environmentally safe way to dispose of [a utility]."*

> *"This program is excellent, please continue it."*

Respondents were also given the opportunity to provide suggestions for improving the RARP. Recurrent themes among the suggested improvements include increasing advertising for the program, improving the scheduling process, and expanding the program to include other household appliances. Specific recommendations included:

> *"They should include other appliances too, like washers, dryers, [and] kitchen appliances."*

"A little hard to get scheduled because we had to do it online which was confusing."

"Do more marketing and let it be known to more people."

"It is hard to have to be here when they pick up the appliances.... I 'm just not sure why I had to be here at the time of pick-up."

5.3.5 Program Operations Perspective

As part of the 2017 process evaluations, the Evaluation Team conducted in-depth interviews with staff from the Company and implementation staff responsible for delivering this program. These interviews provided an update on respondents' roles and responsibilities, program operations, assessed the effectiveness of current program components, such as marketing and outreach and data tracking, and identified areas for program improvement. The findings are summarized by topic area in this section.

5.3.5.1 Roles and Responsibilities

The program is managed by one Company staff member and a program coordinator, who started with the program last year. The program implementation team includes an account manager, who manages the program's daily operations, as well as support from two senior managers.

5.3.5.2 Program Operations

The program implementer, ARCA, started managing the program in mid-2016. The program was fully operational during PY2017; however, it did not meet its goal of recycling 4,000 units. Program staff is optimistic that participation will increase in PY2018, due to greater marketing efforts.

The program implementer communicates regularly with the Company staff in addition to conducting on-site visits several times a year and daily emails.

Overall, the Company's staff are happy with ARCA's management of the program. They noted that hitting participation targets in early PY2017 was a bit of a struggle, but the program participation has steadily increased. ARCA also opened up a customer call center in late 2017 to address the increasing workload and provide faster customer service.

Customer pick-ups are generally scheduled within three weeks of the initial call, with the goal of less than 21 days. However, the program staff explained that it may be difficult to schedule pick-ups during certain times of the year, such as in the winter months, as well as for certain customer locations. ARCA also has a recycling transfer station located in the Company's service territory, to facilitate the recycling process.

5.3.5.3 Program Outreach Activities

As the database analysis showed, there were significant increases in program activity which were tied to marketing and outreach activities. Because of this success, the Company plans on

increasing its marketing activities throughout the year to help reach the program's overall participation goals in PY2018.

The program implementer agreed that the Company's marketing campaign has been a major driver in increasing program participation. The program implementer noted that the targeted marketing in Roanoke has been especially successful, and noted that any marketing the Company can increase overall participation.

In addition, the Company and ARCA program staff are working on increasing marketing activities to include email campaigns, bill inserts, and cross-marketing with other Company programs.

5.3.5.4 Data Tracking and Quality Control

The program data are tracked in customized workbooks that allow the staff to review and manage program operations, including the location of pick-ups, the average age and size of appliances, and savings estimates from the recycled units.

The Company's implementation team is reviewing the savings calculations for the recycled refrigerators and freezers to ensure that they are following the Uniform Methods Approach and are accurately capturing the savings information.

5.3.5.5 Contractor/Customer Feedback

The program staff reported that this program generates high customer satisfaction from its participants.

5.3.5.6 Barriers to Participation

Lack of awareness continues to be a major barrier to program participation, so the Company and ARCA staff are continuing to work closely to increase marketing and outreach activities.

Another major barrier is the rural nature of the Company's service territory, which may require long routes and fewer customer pick-ups. ARCA has invested in smaller trucks that can reach these rural areas, but there is still a lack of volume to these remote locations.

5.3.6 Conclusions and Recommendations

The following conclusions and recommendations are based on findings from the process evaluation for the 2017 RARP.

- The recycling program continues to improve as its new program implementer has made significant enhancements since taking over in mid-2016. These modifications include opening a customer call center and a transfer station to reduce the customer waiting time for an appointment.
- Program activity increased significantly from last year, but it is still only at 35% of its overall goal. There is a direct correlation between program volume and marketing and outreach activities. Therefore, the Company staff should continue to promote this program through a

variety of direct mail methods, including email, bill inserts, and coordinated marketing outreach with other residential programs.

- The program marketing approaches that were most frequently cited as the source of program awareness were bill inserts (25%), emails (15%), and print media (13%). Word of mouth was also cited as a source of awareness for 14% of respondents.
- Participant satisfaction was high – 97% of customers were somewhat or very satisfied with the program overall.
- The Company should also consider involving ARCA in a more proactive way and leverage their experience in running limited promotional campaigns, such as the "ugly fridge contest" or iPad giveaways. These promotional activities have been successful for limited periods for other utility programs, according to the program implementer.
- Considering increasing use of social media to promote the recycling service and incentive to capitalize on participants' tendency to learn of the program through word-of-mouth.
- The Company may want to consider increasing the program incentive for the next program filing from $50 to $75, as this has led to significant increases in participation in other jurisdictions. Another approach to consider is offering a variable incentive that pays $75 for recycled units manufactured before 1990 and $50 for units manufactured after that year. Comparison of the acquisition cost (incentive dollars per kWh saved) may inform the decision of offering a flat versus variable incentive.
- The Company may want to consider expanding the reach of its program to low-income multifamily housing units and small commercial businesses. Expanding the program to reach these market niches, may also be a way to bolster participation going forward.

6 ENERGY STAR Manufactured Housing Program

6.1 Program Description

The ENERGY STAR® Manufactured Housing Program provides home manufacturers with incentives for increasing building envelope, HVAC system, heating, and water heating efficiency for homes built in the Company's service territory. The program is implemented by the Systems Building Research Alliance (SBRA), which is an organization comprised of home manufacturers, retailers, suppliers, and other home manufacturing industry stakeholders. SBRA focuses on improving residential manufacturing efficiency and quality by supporting the development of new technologies, processes, and manufacturing partnerships.

SBRA is responsible for program administration, including recruiting participating manufacturers and providing manufacturer plant certification, field performance verification, and third-party plant certifier oversight. SBRA also provides a zip code lookup tool that allows manufacturers or retailers to determine whether a given home is in the Company's service territory and would be eligible for an incentive through this program.

6.2 Impact Evaluation

This chapter addresses the estimation of gross kWh savings and peak kW reductions resulting from the Company's ENERGY STAR® Manufactured Housing Program.

6.2.1 Methodology for Estimating Gross Savings

The methodology used for estimating gross savings is based upon the Tennessee Valley Authority (TVA) Technical Resource Manual (TRM). The TVA TRM identifies that ENERGY STAR® Manufactured Housing saves energy compared to a minimally compliant U.S. Department of Housing and Urban Development (HUD) home in five key areas. The areas of increased efficiency are as follows:

- Replacing electric resistance strip heating with a heat pump,
- Ceiling insulation being increased from R-11 to R-38,
- Reducing the infiltration of the home from 2,500 CFM to 1,500 CFM at 50 pascals,
- Increase duct insulation from 1" to 2", and
- Replace single-pane windows with double-pane windows.

The TVA TRM savings associated with the aforementioned energy efficiency measures were developed specifically for Tennessee; which, falls in ENERGY STAR® Climate Region 3. As a result of the state of Virginia being situated in ENERGY STAR® Climate Region 2, The Evaluation Team revised the savings associated with ENERGY STAR® Manufactured Housing using the Mid-Atlantic TRM. Energy savings calculations were informed using the following assumptions:

Table 6-1 ENERGY STAR® Housing Assumptions

Variable	*Value*	*Source*
Average Size of Home	1,618 ft^2	2017 Participant Sample
Cooling/Heating Capacity	30,000 Btuh	2016 Participant Sample
Window to Wall Ratio	15%	IECC 2009 Table 405.5.2
Window Area	243 ft^2	-
Average Cooling Efficiency	13.0 SEER	2016 Participant Sample
Average Heating Efficiency	8.0 HSPF	2016 Participant Sample
Equivalent Full Load Cooling Hours	589	Mid-Atlantic TRM, Weather Corrected for VA
Equivalent Full Load Heating Hours	963	Mid-Atlantic TRM, Weather Corrected for VA
Cooling Degree Days	414	Calculated using VA Weather, Base Temp of 75 F as denoted by the Mid-Atlantic TRM
Heating Degree Days	3,021	Calculated using VA Weather, Base Temp of 60 F as denoted by the Mid-Atlantic TRM

The aforementioned ENERGY STAR® Manufactured Housing construction assumptions were then used to inform the following Mid-Atlantic TRM calculations:

6.2.1.1 Replacement of Electric Resistance Strip Heating with Heat Pump

The saving attributed to the replacement of electric resistance strip heating with a heat pump was calculated using the methodology as described in the Air Source Heat Pump section of the Mid-Atlantic TRM V7. The methodology is as follows:

$$\Delta kWh_{heating} = \frac{Cap_h}{1{,}000} \times \left(\frac{1}{HSPF_b} - \frac{1}{HSPF_e}\right) \times EFLH_h$$

Where:

$\Delta kWh_{heating}$	= *Annual heating kWh savings*
Cap_h	= *The heating capacity of the HVAC system in Btuh*
HSPFb	= *Heating Seasonal Performance Factor of electric resistance strip heating, 3.41*
$HSPF_e$	= *Heating Seasonal Performance Factor of heat pump*
$EFLH_h$	= *Equivalent Full Load Hours of operation during the heating season*

6.2.1.2 Increased Ceiling Insulation

The savings attributed to the increase in installed ceiling insulation was calculated using the methodology as described by the Mid-Atlantic TRM V7. The methodology is as follows:

$$\Delta kWh = \left[\frac{\left(\frac{1}{R_b} - \frac{1}{R_e}\right) \times CDH \times DUA \times A}{1{,}000 \times SEER}\right] \times Adj_{cool} + \left[\frac{\left(\frac{1}{R_b} - \frac{1}{R_e}\right) \times HDD \times 24 \times A \times 293.1}{1{,}000{,}000 \times COP}\right] \times Adj_{heat}$$

Where:

ΔkWh	*= Annual kWh savings*
CDH	*= Cooling Degree Hours*
HDD	*= Heating Degree Days*
DUA	*= Discretionary Use Adjustment to account for the fact that people do not always operate their air conditioning, 0.75*
A	*= Area of the ceiling/attic with upgraded insulation in ft^2*
Adj_{cool}	*= 0.8*
Adj_{heat}	*= 0.6*
SEER	*= Seasonal Energy Efficiency Ratio of heat pump*
COP	*= Coefficient of Performance Factor of heat pump*

6.2.1.3 Reduction in Infiltration

The savings attributed to the reduction of air infiltration from 2,500 CFM to 1,500 CFM was calculated using the methodology as described by the Mid-Atlantic TRM V7. The methodology is as follows:

$$\Delta kWh = kWh_{cool} + kWh_{heat}$$

$$kWh_{cool} = \left[\frac{\frac{(CFM_b - CFM_e)}{N_{cool}} \times 60 \times CDH \times DUA \times 0.018}{1{,}000 \times SEER}\right] \times LM$$

$$kWh_{heat} = \left[\frac{\frac{(CFM_b - CFM_e)}{N_{heat}} \times 60 \times 24 \times HDD \times 0.018}{1{,}000{,}000 \times COP}\right] \times 293.1$$

Where:

ΔkWh	= *Annual kWh savings*
kWh_{cool}	= *Annual cooling kWh savings*
kWh_{heat}	= *Annual heating kWh savings*
CFM_b	= *Baseline infiltration at 50 pascals, 2,500*
CFM_e	= *As-Built infiltration at 50 pascals, 1,500*
N_{cool}	= *Conversion from CFM_{50} to $CFM_{natural}$, dependent upon number of stories*
CDH	= *Cooling Degree Hours*
DUA	= *Discretionary Use Adjustment to account for the fact that people do not always operate their air conditioning, 0.75*
$SEER$	= *Seasonal Energy Efficiency Ratio of heat pump*
LM	= *Latent multiplier to account for latent cooling demand*
N_{heat}	= *Conversion from CFM_{50} to $CFM_{natural}$, dependent upon number of stories*
HDD	= *Heating Degree Days*
COP	= *Coefficient of Performance Factor of heat pump*

6.2.1.4 Increase Duct Insulation from 1" to 2"

The savings attributed to the increase in average duct insulation from 1" to 2" was calculated using the methodology as described by the Mid-Atlantic TRM V7. The methodology is as follows:

$$\Delta kWh = \left[\frac{\frac{DE_b - DE_e}{DE_e} \times EFLH_c \times Cap_c}{SEER \times 1{,}000}\right] + \left[\frac{\frac{DE_b - DE_e}{DE_e} \times EFLH_h \times Cap_h}{1{,}000{,}000 \times COP}\right] \times 293.1$$

Where:

ΔkWh	= *Annual kWh savings*
DE_b	= *Distribution efficiency with 1" insulation, 72%*
DE_e	= *Distribution efficiency with 2" insulation, 74%*
$EFLH_c$	= *Equivalent Full Load Hours of operation during the cooling season*
$EFLH_h$	= *Equivalent Full Load Hours of operation during the heating season*
Cap_c	= *The cooling capacity of the HVAC system in Btuh*
Cap_h	= *The heating capacity of the HVAC system in Btuh*
$SEER$	= *Seasonal Energy Efficiency Ratio of heat pump*

COP = *Coefficient of Performance Factor of heat pump*

6.2.1.5 Double-Pane Windows

The savings attributed to the replacement of single-pane windows with double-pane windows was calculated using the methodology as described by the Mid-Atlantic TRM V7. The Mid-Atlantic TRM V7 attributes a prescriptive cooling and heating savings in the units of kWh/100ft^2 of windows installed. The provided savings values are based on a cooling efficiency of 10 SEER and a heating COP of 2.0. The Evaluation Team adjusted these values to reflect the typical efficiency of the HVAC system in a typical ENERGY STAR® Manufactured Home. This results in an annual savings of 165.48 kWh/100ft^2 for heating and 157.69 kWh/100ft^2 for cooling.

6.2.1.6 kW Reduction Savings

Where applicable, the following algorithm was referenced from the Mid-Atlantic TRM V7 to determine savings due to demand reduction.

$$\Delta kW = \frac{\Delta kWh_{cool}}{EFLH_C} \times CF$$

Where:

CF = *0.69*

Demand reduction was not accounted for regarding the "Replacement of Electric Resistance Strip Heating with Heat Pump" since kW reduction is a result of only the cooling portion of kWh savings. The Mid-Atlantic TRM V7 attributes a prescriptive demand reduction regarding the installation of "Double-Pane Windows" equal to 0.12 kW/100ft^2 of windows installed.

6.2.1.7 Estimated Useful Life (EUL)

The Mid-Atlantic TRM was referenced when determining EUL for each energy saving measure. EUL was applied towards calculating the program's lifetime energy savings.

Table 6-2 Effective Useful Life per Appliance

Unit Type	Effective Useful Life
Replacement of Electric Resistance Strip Heating with Heat Pump	18
Increased Ceiling Insulation	25
Reduction in Infiltration	15
Increase Duct Insulation from 1" to 2"	20
Double-Pane Windows	25

6.2.2 Gross Savings Results

The realized gross kWh savings and peak kW reduction are summarized in Table 6-3 and Table 6-4.

Overall, a typical ENERGY STAR® Manufactured Home saves 7,525 kWh annually and 0.35 kW when compared to a minimally compliant HUD home.

Table 6-3 Single Home Expected and Gross Realized kWh Savings per Measure

Measure Description	*Expected kWh Savings*	*Realized Gross kWh Savings*	*Gross Realization Rate*
Replace strip heat with SEER 13 HP	2,362	4,861	206%
Ceiling R-Value = 11 to R-38	479	430	90%
Reduce CFM50 from 2500 to 1500	466	437	94%
Increase duct insulation from 1" to 2"	737	1,013	137%
Replace single-pane with double-pane windows	819	784	96%
Total	4,863	7,525	155%

Table 6-4 Single Home Expected and Gross Realized Peak kW Reduction per Measure

Measure Description	*Expected Peak kW Reduction*	*Realized Gross Peak kW Reduction*	*Gross Realization Rate*
Replace strip heat with SEER 13 HP	0.00	0.00	-
Ceiling R-Value = 11 to R-38	0.09	0.04	49%
Reduce CFM50 from 2500 to 1500	0.14	0.07	53%
Increase duct insulation from 1" to 2"	0.04	0.04	108%
Replace single-pane with double-pane windows	0.21	0.20	96%
Total	0.48	0.35	73%

The expected savings for the 2017 program year references the final realized savings of the Manufactured Homes Program for the 2016 program year. The realization rate can be explained by any changes made between the two program years.

The most impactful revision between the two program years is the environmental data impacting Equivalent Full Load Cooling and Heating Hours ($EFLH_C$ and $EFLH_H$). The 2016 program year used 65 °F as the baseline temperature for both heating and cooling hours, while the 2017 program year used a baseline of 60 °F for heating and 75 °F for cooling hours. Temperature data used to determine EFLH included the last three years.

The Mid-Atlantic TRM V7 was referenced for the 2017 program year, while the Mid-Atlantic TRM V6 was referenced for the 2016 program year. The energy savings methodologies were consistent between the two TRM versions.

A total of twenty manufactured homes were incentivized through the program during 2017. As shown in Table 6-5, applying the per-home kWh savings of 7,525 and kW reduction of 0.35 results in program-level gross savings of 150,501 kWh and 6.97 kW.

Table 6-5 Program Level Expected and Gross Realized Savings

Expected kWh Savings	*Realized Gross kWh Savings*	*Realized kWh Lifetime Savings*	*Gross kWh Realization Rate*	*Expected kW Reduction*	*Realized Gross kW Reduction*	*Gross kW Realization Rate*
97,260	150,501	2,893,380	155%	9.60	6.97	73%

6.2.3 Net Savings Assessment

The Evaluation Team attempted to assess savings through a survey of home purchasers. Partly as a function of the limited program activity, the Evaluation Team obtained too few responses to develop an unbiased estimate of net savings. Given that this is the second year where this has occurred, a home-purchaser approach may not be viable unless there are significant increases in program activity. In future program years, the Evaluation Team will review alternative approaches to assessing net savings including use of manufacture interviews and a literature review of net savings found for similar programs.

6.3 Process Evaluation

The following section presents key findings from the process evaluation conducted for the 2017 MHP. This component of the evaluation is focused on identifying program structures and methods of delivery, as well as assessing overall performance, any existing barriers to program effectiveness, and potential changes in place for future program years.

This evaluation is based upon analysis of program structure and interviews and surveys of participating homeowners, utility and implementation contractor staff.

6.3.1 Summary of Primary Data Collection

- Homeowner surveys: The Evaluation Team conducted surveys with homeowners who had purchased a qualifying ENERGY STAR® manufactured home for which a manufacturer incentive was received in 2017. These surveys focused on the home buying experience, including customer decision making with regard to energy efficiency as well as customer awareness of the program and energy efficient equipment and features.
- Interview with program staff members: Interviews with program management staff from the Company and the program implementation contractor, the Systems Building Research Alliance (SBRA), provided insight into various aspects of the program and its organization. SBRA staff was interviewed to provide information regarding program design, performance thus far, and comparisons to similar programs operated in other service territories.

6.3.2 Program Overview

The ENERGY STAR® Manufactured Housing Program provides the manufacturers with incentives for increasing building envelope, HVAC system, heating, and water heating efficiency for homes built in the Company's service territory. The program is implemented by the Systems Building Research Alliance (SBRA), which is an organization comprised of home manufacturers, retailers, suppliers, and other home manufacturing industry stakeholders. SBRA focuses on improving residential manufacturing efficiency and quality by supporting the development of new technologies, processes, and manufacturing partnerships.

SBRA is responsible for program administration, including recruiting participating manufacturers and providing manufacturer plant certification, field performance verification, and third-party plant certifier oversight. SBRA also provides a zip code lookup tool that allows manufacturers or retailers to determine whether a given home is in the Company's service territory and would be eligible for an incentive through this program.

6.3.2.1 Manufacturer and Residence Requirements

Manufacturers receive $1,400 for each factory-built home that is certified as meeting or exceeding the program's ENERGY STAR® requirements. By providing the incentive to manufacturers directly, the program offsets the cost of energy efficiency improvements at the factory level before retailer markups. This is intended to increase the energy savings per incentive dollar spent. In order to receive an incentive, manufacturers must:

- Build the home that meets or exceeds ENERGY STAR® program requirements, including all required documentation;
- Record the home in SBRA's ENERGY STAR® Information Manager System;
- Install home at building site and conduct the Site Installation Checklist procedures;
- Verify that the heat pump is installed, as required by the program;

- Have site checklist and Quality Assurance label signed;
- Affix ENERGY STAR® and SBRA Quality Assurance labels to home; and
- Archive all relevant documentation for inspection by SBRA.

As stated in program documentation, qualifying homes are equipped with energy efficiency improvements including:

- Thermal envelope improvements
  - Increased envelope insulation
  - Improved duct insulation
  - Tight ducts construction
  - High efficiency windows
  - Tight envelope construction
- High efficiency equipment/control strategies
  - High efficiency heat pumps in place of typically installed electric resistance Furnaces and air conditioning equipment
  - High efficiency domestic water heater
  - Programmable thermostat

6.3.2.2 Reporting

Upon recruiting manufacturers to participate in the program, SBRA is responsible for providing monthly reports to the Company in order to track program participation and record incentive payments. These reports are to include information such as:

- Home information such as manufacturing date, square footage, checklist of measures installed, and homeowner contact information
- Manufacturer information such as parent company name, plant company name, and plant location
- Retailer information such as retailer company name, contact person, and retailer location
- SBRA tracking information such as invoice number, date of receipt, date of approval, and additional notes

6.3.2.3 Quality Assurance Procedures

SBRA maintains a four-tiered structure of quality control to maintain quality at both the manufacturer and residence level. This structure consists of a Design Approval Primary Inspection Agency (DAPIA), an In-Plant Plan Inspection Agency (IPIA), ENERGY STAR® Certifiers, and SBRA staff. In order for a participating manufacturer to use a specific manufacturing design, the design must first be approved by DAPIA staff. Upon approval, the design is incorporated into an eligible ENERGY STAR® package.

On the manufacturing level, IPIA staff verify that that manufacturers are in compliance with the approved design, such as ensuring that the home has the required insulation levels, equipment types, and other features. The ENERGY STAR® Certifiers also verify manufacturer compliance with approved designs in order to ensure that the manufactured homes are consistent with ENERGY STAR® requirements.

The ENERGY STAR® Certifier inspection is separate from the IPIA inspection, and ENERGY STAR® Certifiers also provide training on ENERGY STAR® practices to production staff in the plant. ENERGY STAR® Certifiers conduct ongoing quality assurance and testing of a sample of completed homes. Finally, SBRA staff oversees certification staff and reviews all quality control for the program.

6.3.3 Participating Homeowner Survey

The Evaluation Team conducted surveys with homeowners who had purchased a qualifying ENERGY STAR® manufactured home for which a manufacturer incentive was received in 2017. These surveys focused on the home buying experience, including customer decision making with regard to energy efficiency as well as customer awareness of the program and energy efficient equipment and features. In total, all three of the homeowners who had purchased a home that was incentivized through the program during 2017 responded to the survey. This section highlights key findings from the homeowner survey effort.

6.3.3.1 Awareness of ENERGY STAR® and Efficiency Measures

Respondents were asked a series of questions to assess their awareness of both the ENERGY STAR® certified status of their home and of the energy efficient measures that were installed in order to meet ENERGY STAR® design requirements. As shown in Table 6-6, when asked whether they had known that their home was ENERGY STAR® certified at the time of purchase, all respondents had indicated that at they were indeed aware.

Table 6-6 Awareness of Energy Star® Certified Status by Home Buyers

	Response	*Percent (n = 3)*
When you purchased this home, were you aware that this home was Energy Star certified?	Yes	100%
	No	0%
	Refused	0%

As recorded in Table 6-7, regarding specific home characteristics and equipment, the respondents all reported having been aware that the home contained an energy efficient heat pump. Additionally, respondents generally reported having been aware that the home contained upgraded insulation and double pane windows at the time of purchase; they were less aware of air sealing measures in place. Although this is a small sample size, these anecdotal results

suggest that homeowners have a substantial level of awareness regarding both the ENERGY STAR® status of the home and the individual energy efficiency upgrades that have been incorporated into the home.

Table 6-7 Awareness of Installed Energy Efficient Measures by Home Buyers

	Response	*Percent (n = 3)*
When you purchased this home, which appliances were you aware that this home had:	Heat pump	100%
	Double pane windows	100%
	Insulation upgrades	67%
	Air sealing	33%

6.3.3.2 Awareness of the Program and Pricing Effects

Although the program is primarily targeted to home manufacturers, and homeowners do not directly receive an incentive for purchasing qualifying ENERGY STAR® homes, one objective of the upstream incentive is to decrease the incremental cost of ENERGY STAR® features and ultimately decrease the cost to prospective homebuyers. Additionally, the Company includes customer-facing information about the Manufactured Housing Program on the TakeChargeVA website, and awareness of the upstream incentives may encourage customers to seek out energy efficient homes. When asked whether they were aware of the ENERGY STAR® Manufactured Housing Program that the Company offers to home manufacturers, neither respondent reported being aware of the program. Additionally, neither respondent reported receiving any materials or information from their retailer indicating that the energy efficient features of their home were being offered at a discounted price. As neither of these respondents were not aware of this rebate program or its intended effects, the extent to which the price benefits are being passed on to the homebuyers at the retailer level is unclear.

These responses assist in highlighting the importance of retailers in the manufactured homes market, and suggest that the MHP may benefit from working more closely with retailers to promote ENERGY STAR® housing in future program years.

6.3.4 Program In-Depth Interviews

As part of the 2017 process evaluations, the Evaluation also conducted in-depth interviews with the Company program staff and the implementation contractor staff. These interviews provided an update on respondents' roles and responsibilities, program operations, assessed the effectiveness of current program components, such as marketing and outreach and data tracking, and identified areas for program improvement. The findings are summarized by topic area next.

6.3.4.1 Program Operations

The Company has contracted with Systems Building Research Alliance (SBRA), a non-profit which promotes the ENERGY STAR® Manufactured Housing Program to manufactured homes dealers and builders in the Company's service territory. The goal is to encourage the construction of energy efficient manufactured during the manufactured housing process.

This program is not meeting its projections. According to the Company staff, the goal was to have 230 manufactured homes sold in the utility's service territory in PY2017. However, the program reached only 10% of its goal, with 24 manufactured homes delivered to customers in the utility service territory.

Both the program staff and implementer noted that the program is performing significantly below its goals. However, the program implementer attributed the low participation to several market barriers.

The program implementer also noted that other utility programs in Ohio and Kentucky have also failed to achieve their program participation goals, suggesting a need to redesign the program to address changing market conditions.

According to the program implementer, the MHP Program is competing with an existing program offered by one of the largest manufactured home builders, Clayton Homes. This program, called Energy Smart, only requires increasing the insulation levels of the manufactured home instead of installing a heat pump and increased insulation levels. Since the Energy Smart Program is not as expensive, it is easier for the dealers to promote Clayton Home's Energy Smart Program instead of the "ENERGY STAR Manufactured Homes Program".

The Company program staff also acknowledged the difficulty in competing with a manufactured homes proprietary program; the retailers are actually selling against the ENERGY STAR Program.

The energy efficient Clayton Homes units cost only $200 more than the baseline models while the ENERGY STAR Manufactured Homes Program can cost as much as 5,000 to pay for the heat pump. In addition, the ENERGY STAR program also requires dealers to complete a checklist and site inspection, requirements that are not well-understood by the manufactured homes dealers. The implementer further explained that the current rebate offered by the Company may not be sufficient to cover the incremental cost of the ENERGY STAR Manufactured homes.

As the program implementer explained, the current situation makes it easier for the dealers to sell the Clayton Homes energy efficient models instead of promoting the ENERGY STAR Manufactured Homes program. However, the implementer explained, "This issue is not unique to APCO VA/ We had the same problem in Ohio and Kentucky."

This is an especially high market barrier, as Clayton Homes accounts for approximately 50% of the market share of manufactured homes in the Company's service territory.

6.3.4.2 Proposed Changes in Program Design

The program implementer has been working with ENERGY STAR program manager to redesign the program. The implementer reports that the Environmental Protection Agency (EPA) is in the process of revising the program specifications. Although it is not yet official, the new specifications will eliminate the heat pump requirement and make the revised program essentially identical to Clayton Homes Energy Smart Program.

The strategy going forward will be to co-brand manufactured homes with both the Clayton Homes Energy Smart and the ENERGY STAR program. This approach is currently being piloted by AEP in Ohio. In addition, the rebates will go directly to the Heating, Ventilation, and Air Conditioning (HVAC) contractors to defray the cost of installing heat pumps, as a program add-on.

The program implementer reports that pilot program in Ohio has been well-received by retailers, as this approach is much simpler.

> *"The retailers like this idea because they are selling a better manufactured home. The HVAC guys like selling the heat pumps. It has gotten everybody moving in the right direction."* (Program Implementer)

The program implementer anticipates that this program change will be approved in early 2018 and that will become a "game changer" for the Company.

6.3.4.3 Market Outreach

Last year, the program implementer planned on developing some collateral materials to help promote the ENERGY STAR program; however, those plans are on hold until there is a solution to the current competing programs.

Other marketing and outreach materials are not viewed as effective, such as the program website. As the program implementer explained, most customers rely on the local retailers to provide this type of information.

Once the program changes have been approved, then SBRA will launch a media blitz to educate both retailers and HVAC contractors about the new program requirements.

6.3.5 Conclusions and Recommendations

The following conclusions are based on the impact evaluation and process evaluation findings from the 2017 program year.

- The current program design has been ineffective in reaching the Company customers, due to the presence of a competing, but less comprehensive, energy efficiency program offered by a major manufactured homes builder. This barrier has created similar challenges in other AEP service territories in Ohio and Kentucky.
- The program implementer has been working proactively with EPA to develop a revised manufactured homes program specification that aligns with the Energy Smart Program,

offered by Clayton Homes. This program design would eliminate the requirement for a heat pump installation and instead provide rebates directly to HVAC contractors to install heat pumps on qualifying units.

- Marketing and outreach materials are on hold until a new ENERGY STAR specification has been approved.
- The Company should monitor the process of revising the current program specification. Once it is approved, they should work with the program implementer to educate dealers about the new program requirements. Additionally, in redesigning the program, staff should ensure that when aligning the program with the Clayton Homes Energy Smart Program, it would be effective at encouraging additional sales of manufactured homes, or result in greater home efficiency, than would be expected to happen in the absence of the Company program.
- The Company should continue to monitor the participation process throughout PY2018 to determine if these revised program standards will be effective in achieving overall program goals.

7 Residential Peak Reduction Program

7.1 Program Description

The Residential Peak Reduction Program is a direct load control program that installs a load control device on the central air conditioner/heat pump of participating homes. During a limited number of peak demand periods, the Company activates the devices to adjust the air conditioners' compressor to run at 50 percent cycling. In 2017, participating customers received an $8.00 monthly bill credit for each central cooling unit controlled during the billing months of May through September. The load control device is installed free-of-charge at participating / qualifying households.

7.2 Impact Evaluation

This section addresses the estimation of peak kW reductions and gross kWh savings resulting from the Peak Reduction Program.

7.2.1 Evaluation Objectives

The year 2017 was the third season of operation for the Peak Reduction Program. Five Peak Reduction events were called which coincided with four of the five PJM coincident peak (5CP) days. In addition, the implementation team continued to recruit and enroll customers and install devices

As part of the evaluation effort for 2017, the Evaluation Team collaborated with the Company and Honeywell, the Company's program implementation contractor for program year 2017, to determine the following metrics:

- What was the maximum achieved demand reduction in summer 2017?
- What were the total energy savings per event and for the entire 2017 event season?

The following sections discuss the methodology and impacts for the 2017 Peak Reduction season.

7.2.2 Methodology

Peak reduction and energy savings for each event were calculated using runtime data from a subsample of the participating device population, weather data, and an engineering conversion for kW per unit.

7.2.2.1 Baseline Runtime Calculation

The baseline runtime was estimated for each participant by hour using a regression model of runtime vs a construct known as the weighted temperature humidity index (WTHI). This method,

which was originally proposed by PJM, is often used in M&V efforts to estimate residential direct load control.

Temperature and humidity measurements from the closest weather station to each participant (Roanoke or Lynchburg weather stations) were used. WTHI is calculated as shown in Equation 1 from the temperature humidity index (THI) from the current and previous days. THI, as shown in Equation 1, is calculated from the temperature and humidity. The maximum daily WTHI was used in the analysis.

Equation 1

$$WTHI = \frac{4 * THI_{Current\ Day} + THI_{Previous\ Day}}{5}$$

Equation 2

$$THI = Temperature_{°F} - .55 * \left(1 - \frac{\%\ Relative\ Humidity}{100}\right) * (Temperature_{°F} - 58.0)$$

Regression models (Equation 3) were generated for each participant for each hour using hourly ending runtime data for non-event days from May through September, which was provided by Honeywell, and the WTHI data. The estimated runtime could then be calculated using the slope, intercept, and WTHI for event days to generate baseline runtimes on event days by day and hour for each participant. Regression models were only generated for participants that had greater than 50 days of runtime data, to increase the stability of the models.

Equation 3

$$Runtime = Slope * WTHI + Intercept$$

Figure 7-1 shows the average modeled versus actual runtimes for non-event days for the subsample population of participants.

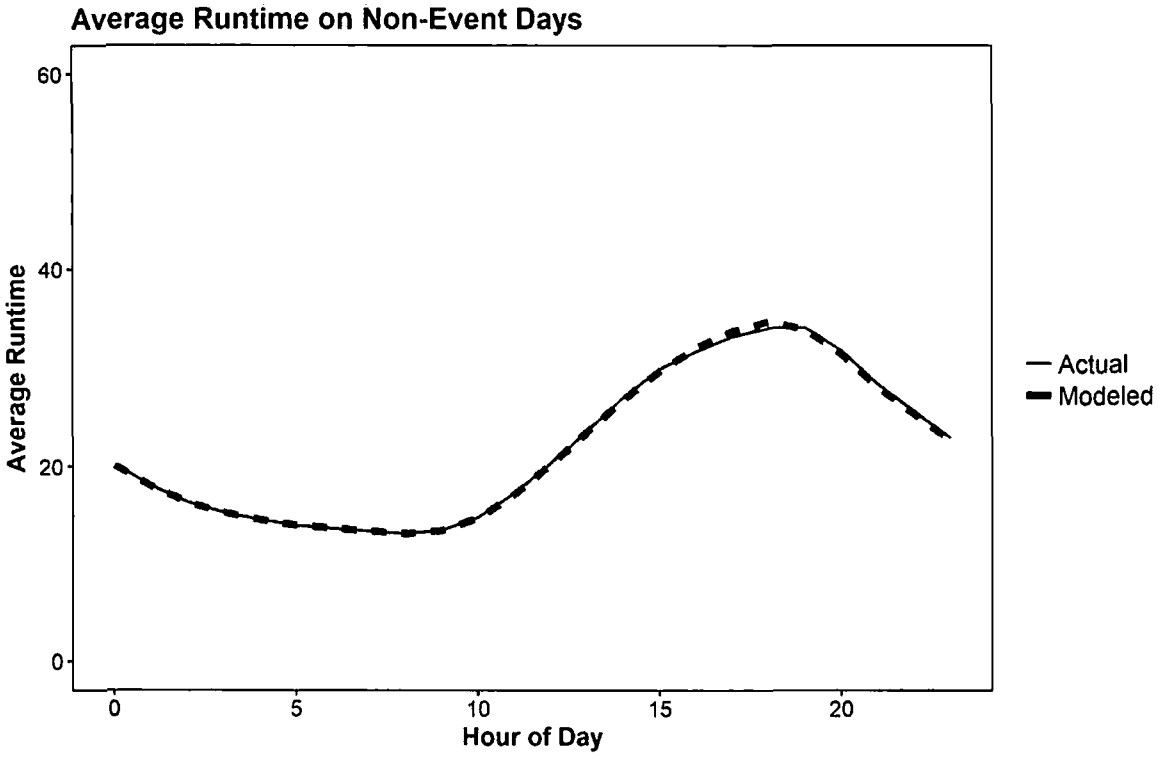

Figure 7-1 Average Modeled and Actual Runtimes

7.2.2.2 kW and kWh Savings Calculation

Because the Evaluation Team used runtime data, an engineering conversion factor of kW per ton for each unit was calculated, to convert to kW and kWh savings. The kW per ton for each unit was calculated from the Seasonal Energy Efficiency Ratio (SEER), which is a function of a unit's age and energy efficiency, according to Equation 4 and Equation 5. The average kW per unit was calculated to be 3.27 kW/unit according to Equation 6.

Equation 4

$$unit\ \frac{kW}{Ton} = \frac{12}{1.12 * SEER - 0.02 * SEER^2}$$

Equation 5

$$kW\ per\ unit = System\ Size\ (ton) * \left(unit \frac{kW}{ton}\right)$$

Equation 6

$$average\ kW\ per\ unit = \frac{1}{n}\sum_{i=1}^{n} kW\ per\ unit_i$$

The average baseline and actual runtimes by hour were calculated over all the participants with runtime data for each event day. A normalization constant, which is calculated as the ratio of the average actual and baseline runtimes an hour before the event, was applied to the baseline runtimes to account for any differences between the groups. An example of the plotted normalized baselines and actual runtimes for the 7/19/2017 event is shown below.

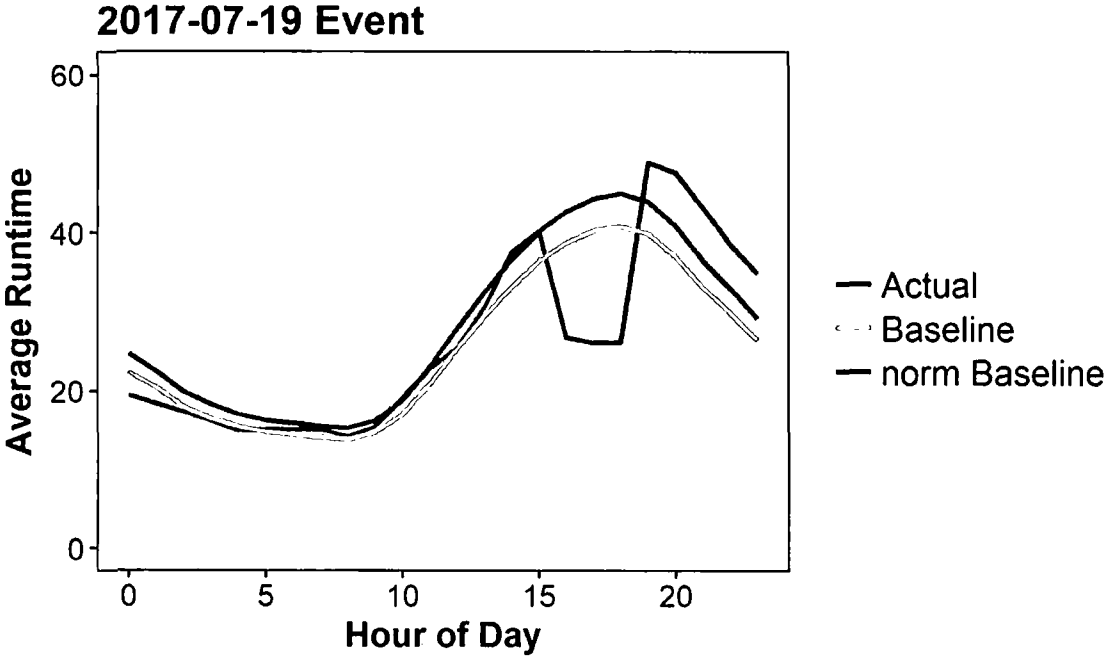

Figure 7-2 Event Plot Example

The runtime reduction for each event hour on event days was calculated by taking the difference between the normalized-baseline run time and actual run time, as shown in Equation 7.

Equation 7

$$runtime\ reduction = runtime_{baseline} - runtime_{actual}$$

The maximum kW was calculated by first finding the maximum of the hourly average runtime reduction across all participants and then multiplying by the average kW per unit for the entire population (Equation 11). The Peak kW Reduction was calculated by multiplying the mean

hourly kW reduction per participant by the number in the entire participant population (Equation 9).

Equation 8

$$kW\ reduction\ per\ participant = \frac{1}{n}\sum_{i=1}^{n} runtime\ reduction_{i,hour} * average\ kW\ per\ unit$$

Where,

n = Number of event participant with runtime data

Equation 9

$$Peak\ kW\ Reduction = kW\ reduction\ per\ participant * N$$

Where,

N = Total number of event participants

The kWh savings per participant for each event was calculated by summing the average runtime reduction across all event hours and a two-hour snapback period and multiplying by the average kW per unit for the entire population (Equation 10). The kWh Savings was calculated for each event by multiplying the kWh saving per participant by number in the entire participant population, according to Equation 11.

Equation 10

$$kWh\ per\ participant = \sum_{hour=1}^{m}\left(\frac{1}{n}\sum_{i=1}^{n} runtime\ reduction_{i,hour}\right) * average\ kW\ per\ unit$$

Equation 11

$$kWh\ savings = kWh\ savings\ per\ participant * N$$

7.2.2.3 Fan Penalty Calculation

Although the load control switch cycles the outdoor unit during the hours of an event, the indoor unit fan runs without any limitations. By turning off the outdoor unit during peak demand periods, the house temperature increases and causes the fan to run more than its normal operation

time. It was assumed that the fan was on during the reduced runtime. The Fan Penalties for both peak kW reduction and kWh savings were calculated using Equation 12 and Equation 13.

Equation 12

$$Fan\ Penalty_{kW} = \frac{\frac{1}{n}\sum_{i=1}^{n} runtime\ reduction_{i,hour}}{60} * 0.18 * average\ system\ size$$

Equation 13

$$Fan\ Penalty_{kWh} = \frac{\sum_{hour=1}^{m}\left(\frac{1}{n}\sum_{i=1}^{n} runtime\ reduction_{i,hour}\right)}{60} * 0.18 * average\ system\ size$$

The Evaluation Team calculated the final kW reduction and kWh savings by subtracting the additional fan usage penalty using Equation 14 and Equation 15.

Equation 14

$$Final\ Peak\ kW\ Reduction = Peak\ kW\ Reduction - Fan\ Penalty_{kW}$$

Equation 15

$$Final\ kWh\ Savings = kWh\ Savings - Fan\ Penalty_{kWh}$$

7.2.3 Energy Savings and Demand Reduction Results

The Company initiated five load management events during the summer of 2017. PJM RTO load did not materialize as PJM had forecasted. As reference, PJM's forecast for 2017 was 152,999 MW. As shown in Table 7-1 below, the Company was successful in initiating events that coincided with the top four PJM coincident peak (CP) days.

Table 7-1 kW PJM Loads and Peak Reduction Event Times

PJM MW Load	*Date*	*Peak Occurred Hour Ending*	*Time Period Called*	*Hit 5CP?*
145,331	7/19/2017	18	15:00 to 18:00	Yes
145,097	7/20/2017	17	15:00 to 18:00	Yes
142,003	7/21/2017	17	15:00 to 18:00	Yes
140,660	6/12/2017	18	15:00 to 18:00	Yes
132,049	9/25/2017	17	16:00 to 18:00	No

The demand reductions were calculated for each event hour. Hourly results are provided below in Table 7-2 for both the Peak Reduction events, as well as the two-hour snapback period following the event. Event hours are represented with gray fill and 5CP hours are represented with red font.

Table 7-2 kW Reductions for Event Days by Hour

Hour	*6/12/2017*	*7/19/2017*	*7/20/2017*	*7/21/2017*	*9/25/2017*
3:00 PM - 4:00 PM	2,207.20	2,781.38	3,326.87	3,170.68	
4:00 PM - 5:00 PM	2,824.59	3,206.32	4,440.58	4,311.00	1,516.75
5:00 PM - 6:00 PM	3,129.59	3,293.33	4,592.08	4,116.15	2,119.07
6:00 PM - 7:00 PM	-52.60	-858.96	236.72	-25.54	-618.88
7:00 PM - 8:00 PM	-738.28	-1,174.07	-727.61	-679.32	-66.22
Event-Level Mean Hourly kW Reduction	2,720.46	3,093.68	**4,119.84**	3,865.94	1,817.91
Maximum Event Hour kW Reduction	3,129.59	3,293.33	4,592.08	4,311.00	2,119.07

The Evaluation Team determined that the peak demand reduction in Virginia was 4,119.85 kW on July 20, 2017, a 5CP day, as shown in Table 7-3. At this point in the season, there were 3,757 active participants during this event day. This represents a peak demand reduction of 1.1 kW per load control switch, which is higher than the 0.9 kW per switch originally estimated.

Table 7-3 kW Reductions for Event Days

Event	*Runtime Reduction (min)*	*Participants*	*Peak kW Reduction*	*Fan Penalty$_{kw}$*	*Final Peak kW Reduction*
6/12/2017	16.9	3,465	3,200.13	479.67	2,720.46
7/19/2017	17.7	3,757	3,639.15	545.47	3,093.68
7/20/2017	23.6	3,757	4,846.25	726.41	**4,119.85**
7/21/2017	22.1	3,760	4,547.58	681.64	3,865.95
9/25/2017	9.0	4,340	2,138.44	320.53	1,817.91

The energy savings associated with each event day are presented in Table 7-4. Summing the energy savings over all events resulted in an overall season kWh savings of 40,331 kWh.

Table 7-4 kWh Savings During Event Days

Event	*Runtime Reduction (min)*	*Participants*	*kWh Savings*	*Fan Penalty$_{kWh}$*	*Final KWh Savings*
6/12/2017	46	3,465	8,670	1,300	7,371
7/19/2017	42	3,757	8,526	1,278	7,248
7/20/2017	68	3,757	13,961	2,093	11,869

7/21/2017	62	3,760	12,814	1,921	10,893
9/25/2017	15	4,340	3,471	520	2,951
				Total kWh Savings	40,331

Table 7-3 presents the total energy savings and demand reductions attributable to the Peak Reduction Program in Virginia for the 2017 program year.

Table 7-5 Realized kWh Savings and kW Reduction for 2017

Expected kWh Savings	*Expected Peak kW Reduction*	*Realized kWh Savings*	*Realized kW Reduction*	*kW Realization Rate*	*kWh Realization Rate*
50,730	4,417.22	40,331	4,119.85	93%	80%

7.3 Process Evaluation

This chapter presents the results of the process evaluation of the Company's Peak Reduction Program during 2017. This evaluation is based upon analysis of program structure, tracking data, and program staff interviews.

7.3.1 Evaluation Objectives

Key research questions to be addressed by this evaluation of 2017 activity include:

- What was the customer attrition (program dropout) rate in 2017?
- What changes have been made to the program since the 2016 program year?
- How effectively has the program performed? Have past operational issues been addressed?
- How have customers responded to event activity? How satisfied are participants with the program overall?

During the evaluation, data and information from multiple sources were analyzed to achieve the stated research objectives. Insight into the customer experience with the Peak Reduction program is developed from a telephone survey of program participants. Further information regarding the program's internal structure and performance is obtained through a review of program documentation such as participant tracking data, as well as interviews with program staff.

7.3.2 Customer Attrition Rate

According to program tracking data, 109 devices were removed from customer homes during the 2017 program year. The total number of 2017 installs (counting unique customers) was 1,543 and the total number of participants from 2015 was 1,863. The attrition rate is approximately six percent. One should note that the events during 2017 resulted in relatively minor reductions in AC run time, so customers may not have been subject to noticeable discomfort. The Evaluation Team estimates, as described in subsequent sections, that the average participant's AC run time was limited to a maximum of 30 minutes per hour as per the 50% cycling strategy implemented

during 2017, whereas it would have been 44 minutes per hour in the absence of demand reduction events. The low attrition rate suggests that the Company and Honeywell can attempt more stringent shed schemes, such as limiting the AC runtime to 15 minutes per hour.

7.3.3 Summary of Primary Data Collection

- **Review of program documentation and relevant literature:** The Evaluation Team reviewed relevant program planning documents and program tracking data in order to assess the current state of program documentation.
- **Participant surveys:** Participant surveys served as the foundation for understanding the customer perspective. The participant surveys provided customer feedback and insight regarding customer experiences with the Peak Reduction program. Participants also relayed their experiences responding to peak reduction events, as well as their satisfaction with the program, contractor professionalism when installing the switch and the different elements of the program from enrollment to scheduled visit to monthly bill credit receipt.
- **Program staff interviews:** The Evaluation Team conducted in-depth interviews with staff of the Company and with Honeywell in order to gain insight into program design and delivery during 2017. The interviews focused on various aspects of program operations, including customer recruitment, signaling during event days, and data collection.

7.3.4 Program Database Findings

The Evaluation Team reviewed the program records and identified installations and removals at unique customer premises.

Figure 7-3 summarizes the switch installation and removal activity throughout the program year. As this figure shows, the number of switch installations peaked during the summer months, with 364 devices installed in August. August was also the peak month for removals. Overall, there were a total of 1,576 devices installed in PY2017 installed compared to 113 removed during the same time period. Of note, these removals include devices that were installed in previous years.

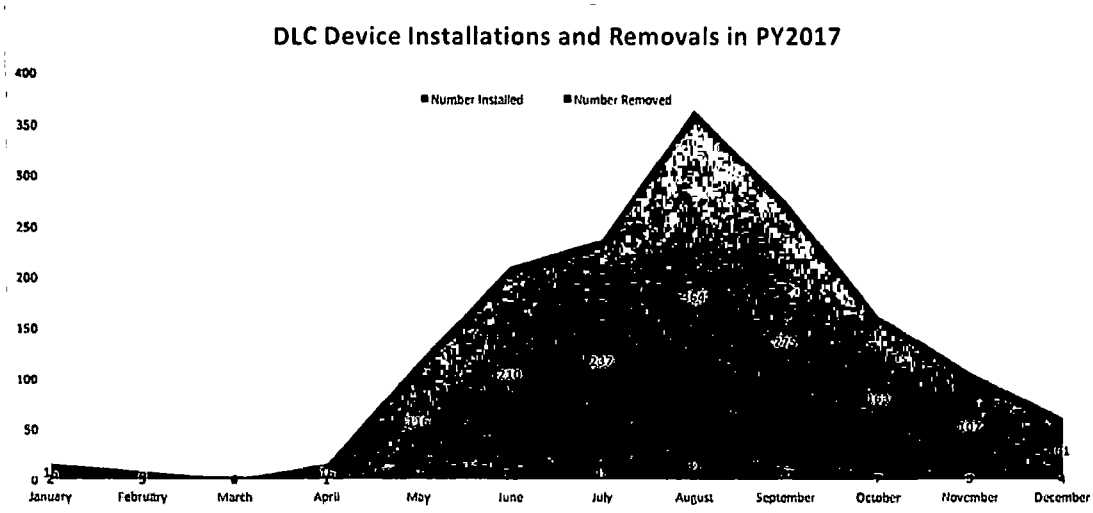

Figure 7-3 DLC Switch Installations and Removals in PY2017

Table 7-6 summarizes the number of installations and removals by city during the PY2017 program year.

Table 7-6 Summary of Total Switch Installation and Removals by City in PY2017

City	*Number of Installations*	*Number of Removals*
ABINGDON	83	3
AMHERST	12	2
BLACKSBURG	68	5
BLUEFIELD	8	3
BOONES MILL	10	2
CHRISTIANSBURG	53	4
DALEVILLE	6	3
FAIRLAWN	3	2
FINCASTLE	5	1
FOREST	86	5
GATE CITY	5	1
GOODVIEW	11	1
HARDY	25	1
LEBANON	7	1
LYNCHBURG	252	10
MARTINSVILLE	37	1
MAX MEADOWS	4	1
MONETA	59	7
RAVEN	2	1
ROANOKE	410	38

City	*Number of Installations*	*Number of Removals*
ROCKY MOUNT	23	3
SALEM	17	5
SPENCER	6	1
STUART	5	1
TROUTVILLE	11	2
VINTON	20	3
WIRTZ	14	2
WOODLAWN	4	1

7.3.5 Participant Survey Findings

The following section presents key findings from surveys conducted with customers who participated in 2017 of the Company's Residential Peak Reduction Program (PRP).

Telephone surveys were conducted with program participants as part of the evaluation effort for the 2017 Peak Reduction Program. The participant survey instrument was designed to gather information regarding the participant perspective on their experiences in the program, as well as to characterize customer preferences and decision making with regard to energy efficiency. Specifically, data collected via participant surveying are used in evaluating:

- Customer awareness of the program;
- Customer decision making behaviors;
- Customer experiences during demand reduction events; and
- Customer satisfaction with the program.

In total, 126 customer participants who enrolled in the program and participated in peak events during 2017 responded to the survey. Telephone surveys were administered by VuPoint Research, and the Evaluation Team performed quality control checks on the collected data.

7.3.5.1 Participant Program Awareness

Survey participants were first asked how they learned about the Peak Reduction Program. As shown in Figure 7-4, the majority of respondents reported that they had learned of the program from utility bill inserts (35%), followed by direct mail (23%).

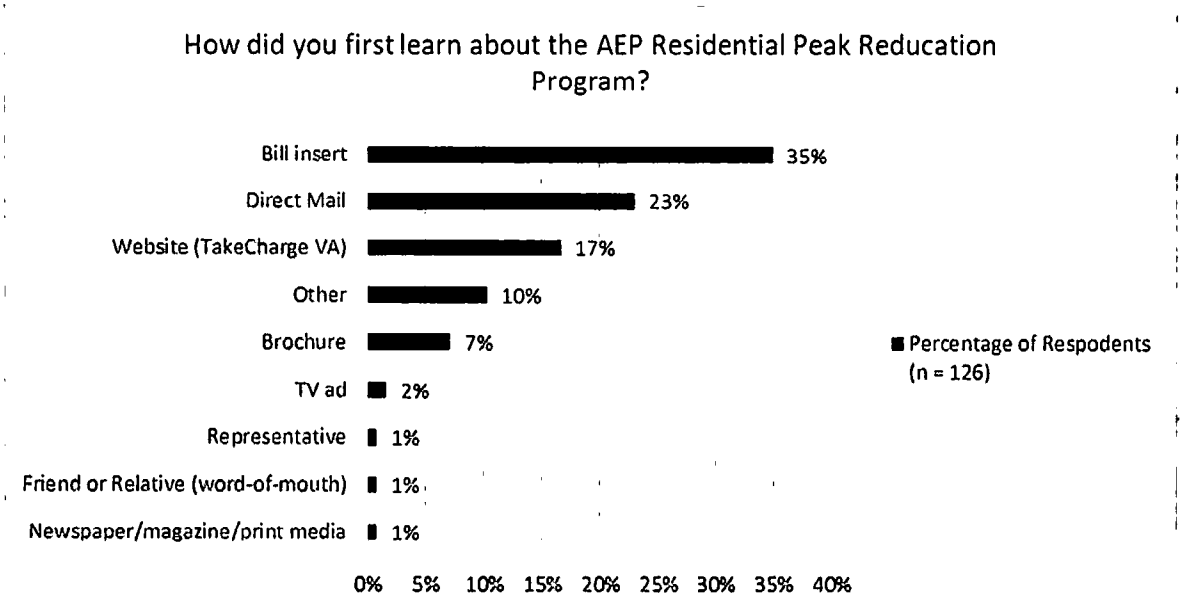

Figure 7-4 Sources of Participant Program Awareness

7.3.5.2 Factors Affecting Participation

As shown in Figure 7-5, the opportunity to participate in an energy savings program (75%) and the desire to receive a monthly bill credit (69%) were the most frequently-reported reasons for participating in the program. [45] Among those respondents whose responses fall under "Other" (4%), most commonly cited environmental and financial considerations as their reason for participating in the program.

[45] Respondents were able to provide multiple responses, and the percentages shown are the percentages of responses to all respondents, rather than the percentages of responses to all responses. Thus, the total exceeds 100%.

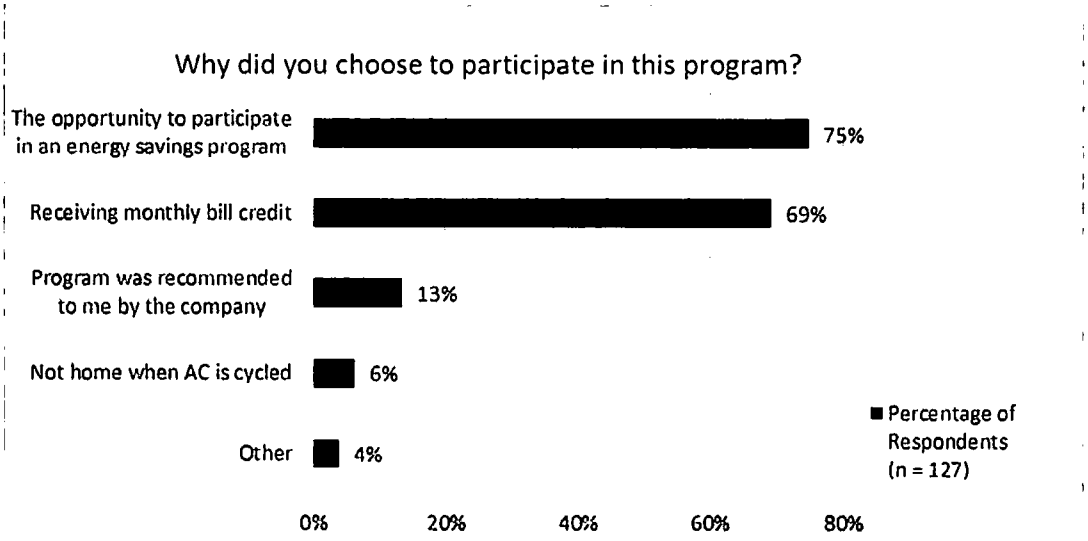

Figure 7-5 Reported Reasons for Participation in Peak Reduction Program

When asked whether they had any initial concerns about participating in the program, 29% of respondents indicated that they had concerns about the program before deciding to participate. The specific concerns mentioned by the 29% of respondents who had concerns about participating are illustrated in Figure 7-6. The most commonly mentioned concern among respondents was with the prospect of being uncomfortable during energy reduction events (mentioned by 73% of respondents with concerns about participating). Concerns regarding the utility possessing control over their AC unit as well as the load control device potentially damaging their AC unit were also significant, cited by 35% of respondents each response option.

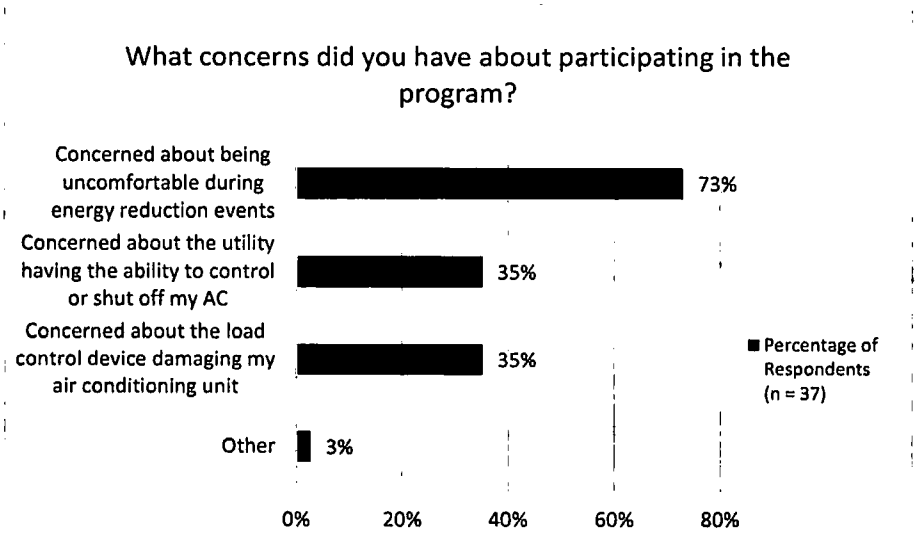

Figure 7-6 Initial Participation Concerns towards the Company Peak Reduction Program

7.3.5.3 Participant Experiences during Reduction Events

Forty-eight percent of respondents indicated that they were home for at least one event. As shown in Table 7-7, when asked about their comfort level during the events that occurred while they were at home, 44% reported being somewhat comfortable or very comfortable, 20% reported being neither comfortable nor uncomfortable, and 28% reported being somewhat uncomfortable or very uncomfortable.

Table 7-7 Participant Awareness of Reduction Events

	Response	*Percent of Respondents (n = 60)*
Thinking about the events that occurred when you were home, how uncomfortable or comfortable were you with the temperature of your home during the energy reduction events?	Very comfortable	42%
	Somewhat comfortable	2%
	Neutral	20%
	Somewhat uncomfortable	8%
	Very uncomfortable	20%
	Don't know	8%

These results indicate that the majority of participants did not experience great discomfort due to the reduction events. As event awareness is not a priority for the program, these results suggest that the program is operating successfully without greatly affecting customers' experience.

7.3.5.4 Participant Behavior during Cycling Season

Eighty-three percent of respondents did not have an expectation of the number of events that would occur during the year. Respondents who did expect a certain number of events were asked how their expectation compared to the actual number of events that took place. As shown in Table 7-8, a majority of these respondents (63%) reported that the number of events that occurred during 2017 was about what they expected.

Table 7-8 Participant Expectation of Event Frequency

Was the number of events that occurred this summer about what you were expecting when you signed up for the program, more than you were expecting, or fewer than you were expecting?	*Response*	*Percent of Respondents (n = 8)*
	More than expected	13%
	About what was expected	63%
	Fewer than expected	0%
	Don't know	25%

One respondent opted out of one or more events during the 2017 event season. The respondent indicated the reasons they opted out was because they had experienced problems with the Peak Reduction Program device installation and was concerned about the potential damage that would occur to their AC unit as a result of installation.

7.3.5.5 Participant Satisfaction

Survey respondents were first asked about their levels of satisfaction with selected elements of the Peak Reduction Program experience with regards to the contractor who visited their home to install the switch on the participant's air conditioner. Results were provided on a scale of *1* to *5*, with *1* representing "very dissatisfied" and *5* representing "very satisfied".

As displayed in Table 7-9, more than 60% of respondents reported being very satisfied with each listed element of the installation experience. Very few respondents reported dissatisfaction with the contractor (3-4%).

Table 7-9 Participant Satisfaction with Contractor Visit Elements

Program Element	Satisfaction Rating						N	Overall % Satisfied	Overall % Dissatisfied
	Very satisfied	Somewhat satisfied	Neutral	Somewhat dissatisfied	Very dissatisfied	Don't know			
	-5	-4	-3	-2	-1				
Information provided by that explained program requirements	70%	25%	3%	1%	1%	1%	126	95%	2%
Scheduling process for equipment installation	68%	16%	5%	6%	5%	1%	126	84%	11%
Monthly bill credit	64%	15%	5%	1%	3%	11%	123	79%	4%
The effort required by the application process	68%	20%	6%	2%	3%	0%	123	88%	5%

Survey respondents were then asked about their levels of satisfaction with other selected elements of the Peak Reduction Program experience. Results were also provided on a scale of *1* to *5*, with *1* representing "very dissatisfied" and 5 representing "very satisfied". As displayed in Table 7-10, respondents reported being most satisfied with the information provided about program requirements (95%), followed by the effort required by the application process (88%). Dissatisfaction was greatest with the process for scheduling the equipment installation – 11% of participants were dissatisfied with this aspect of the program. The most often mentioned issue was the time it took to get the equipment installed. Two respondents also noted that they were not contacted prior to arrival and one noted they did not know who to contact about when the equipment would be installed.

Table 7-10 Participant Satisfaction with Selected Program Elements

Program Element	Satisfaction Rating						N	Overall % Satisfied	Overall % Dissatisfied
	Very satisfied -5	Somewhat satisfied -4	Neutral -3	Somewhat dissatisfied -2	Very dissatisfied -1	Don't know			
Information provided by that explained program requirements	70%	25%	3%	1%	1%	1%	126	95%	2%
Scheduling process for equipment installation	68%	16%	5%	6%	5%	1%	126	84%	11%
Monthly bill credit	64%	15%	5%	1%	3%	11%	123	79%	4%
The effort required by the application process	68%	20%	6%	2%	3%	0%	123	88%	5%

Of the nineteen respondents who indicated that they had interactions with program staff, a majority cited being satisfied or very satisfied (90%) with their interactions with program staff (see Table 7-11).

Table 7-11 Participant Satisfaction with Program Staff Interactions

	Response	Percent (n = 19)
How satisfied are you with your interactions with program staff? Would you say...	Very satisfied	37%
	Satisfied	53%
	Neither satisfied nor dissatisfied	5%
	Dissatisfied	5%
	Very dissatisfied	0%

Respondents who indicated being dissatisfied with one or more elements of the program were asked to explain the reason for their dissatisfaction. Most sources of dissatisfaction were related to late receipt of bill credits, the scheduling process, and poor communication between them and the contractors. Examples of comments from these respondents include:

"It took several months for someone to come and install equipment."

"The contractor did not contact prior to arrival & did not install on both units as they were supposed to do."

"Have not [received] any credits to date."

As shown in Figure 7-7, 62% of respondents indicated that their experience with the program had positively affected their satisfaction with the Company. Another 36% reported that it did not affect their satisfaction and a small minority, 2%, reported that the program decreased their satisfaction.

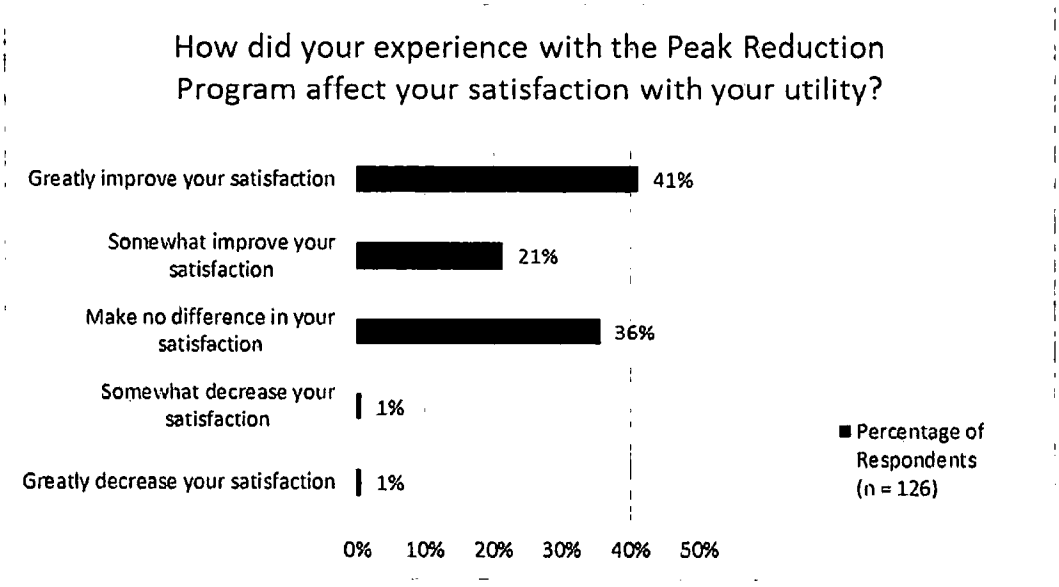

Figure 7-7 Change in Satisfaction with the Company as Utility Provider

Sixty percent of respondents indicated that their participation had increased their familiarity with ways to save energy and 31% said it did not have this effect. Additionally, 15% of respondents reported that the Peak Reduction Program has changed how they use energy in their home. When asked to explain how the program has changed the way they use energy, respondents provided a variety of behavioral changes, including adjusting thermostat settings, turning off lights, and unplugging unused appliances. Some respondents also reported making low cost, energy efficient upgrades to their home, such as switching to energy-efficient lightbulbs and installing wall insulation.

Respondents were asked whether they had recommended the program to friends, family members, or colleagues, and the majority of respondents (52%) reported that they had done so. The remaining respondents were asked how likely they would be to recommend the program, based on their experience thus far. As shown in Table 7-12, 81% of respondents indicated that they are somewhat likely or very likely to recommend the program to friends, family, or colleagues. Ten percent of respondents stated that they are somewhat unlikely or very unlikely to recommend the program, although the reasons for this were not clear.

Table 7-12 Participant Likelihood to Recommend Program

	Response	*Percent of Respondents (N = 51)*
Based on your experience with the Peak Reduction Program, how likely are you to recommend it to your friends, family members, or colleagues?	Very likely	25%
	Somewhat likely	56%
	Somewhat unlikely	5%
	Very unlikely	5%
	Don't know	7%
	Refused	0%

To gauge the potential for attrition from the program, respondents were asked if they were planning on continuing their participation in the program over the next year. As shown in Table 7-13, 90% of respondents replied "Yes" to participating in the program during 2018. Two percent of respondents indicated that they do not plan to participate in the program in 2018.

Table 7-13 Participants Continuing Participation Next Year

	Response	*Percentage of respondents (N = 126)*
Do you plan to continue participation in the program next year?	Yes	90%
	No	2%
	Don't Know	8%

7.3.5.6 Customer Demographics

The customer survey resulted in several demographic findings that may be relevant to future program design and operations.

Respondents were first asked about the type of heating system in their home and, their responses are shown in Table 7-14. Fifty-three percent reported having electric heating, while 20% reported having natural gas heating.

Table 7-14 Type of Heating System in Home

	Response	*Percent of Respondents (N = 127)*
What type of heating system do you have in your home?	Electric heating	53%
	Combination of types	21%
	Natural gas heating	20%
	Other	6%
	Refused	1%

Respondents were next asked about the type of water heater in their home, as shown in Table 7-15. Seventy-four percent reported having an electric water heater, while 23% reported having a natural gas water heater.

Table 7-15 Type of Water Heater in Home

	Response	*Percent of Respondents (N = 98)*
What type of water heater do you have in your home?	Electric water heater	74%
	Natural gas water heater	23%
	Other	3%
	Don't know	0%
	Refused	0%

7.3.6 Program Operations Perspective

As part of the 2017 process evaluations, the Evaluation Team also conducted in-depth interviews with the Company program staff and the implementation staff responsible for delivering this program. These interviews provided an update on respondents' roles and responsibilities, program operations, assessed the effectiveness of current program components, such as marketing and outreach and data tracking, and identified areas for program improvement. The findings are summarized by topic area in this section.

7.3.6.1 Respondent Roles and Responsibilities

The program operates for five months throughout the spring and summer seasons. The program manager has the overall responsibility for operating the program, including calling peak curtailment events. Honeywell, the program implementation contractor, is responsible for installing, testing, and removing switches and ensuring that the switches operate correctly during called events.

7.3.6.2 Program Operations

The Company called a total of five events, of which four were peak load days for PJM. Overall, the Company staff reported that these were successful events, with most of the switches performing as expected. The staff also reported that they were able to send out signals successfully during test events as well.

The program participation was 50% of the goal for number of switches installed, which is consistent with the previous two years. Initially, the goal was to install 3,000 load control switches, however, in its recently approved filing to extend this program, this goal has been lowered to 2,000, 2,500 and 2,500 load control switches in program years 2018, 2019 and 2020, respectively.

> *"This has been one of the best program years, but we still had trouble hitting targets. But we have still installed more switches than in prior years and the program is going quite well."* (Program Implementer)

The Company staff also noted there were occasional issues with properly crediting customer bills. This is due to a delay in notification from Honeywell, which the Company worked diligently with Honeywell to resolve. However, with the change of implementation contractors and the move to end of season check to customers rather than bill credits, this issue will be resolved.

One ongoing issue that has not yet been resolved is that some parts of the Company's service territory are unable to receive the signals as they are located in "dead spots." This can result in dispatching an installer to a customer's home only to find out the customer does not qualify for the switch installation. However, the implementer has minimized the impact by not targeting those areas for signal installation.

Overall, the program attrition rate also remains low. The program implementer reported that the switch removal rate was a relatively small percentage of 4-5% annually and 7% cumulatively. The implementer indicated that this was about average for these types of programs.

7.3.6.3 Marketing Outreach Activities

To increase program enrollment, the Company and the implementer changed its overall marketing approach. Instead of relying only on direct mailings, customers are also learning about the program during a home assessment through the Home Performance Program. The

implementer explained that this more personalized approach has been more effective in overcoming customer reluctance to install a device on their cooling system.

> *"We are focusing on face-to-face interactions whenever we can. The in-person element has the opportunity to establish trust and the connection with the customer, explain to the customer and chance to overcome initial objections."* (Program Implementer)

The energy auditor explains the program and then refers the customer to a participating contractor who installs the switches.

> *"We are shifting how we deliver the program and are leveraging the trade allies who are already (involved) in the program."* (Program Implementer)

The Company staff also worked with its internal team to develop an animated video describing the program. This short video is posted on the program website TakeChargeVA.com.

7.3.6.4 Data Tracking and Quality Control

Both the program staff and implementer reported that program information is communicated in a timely manner. The implementer has developed standard reporting templates which streamlines monthly reporting. The Company staff can also export customized reports from the Honeywell website as needed.

7.3.6.5 Barriers

This program still faces several barriers including customer hesitancy to install these switches.

The participation goals will continue to be evaluated in the next program cycle, according to the program staff.

There are still parts of the Company's service territory where customers are skeptical about these types of programs. However, the Company, in conjunction with its new program implementation contractor, will work with local HVAC contractors to further engage customers in the program.

7.3.6.6 Areas for Program Improvement

As required in the Final Order in PUR-2017-00094, the Company analyzed potential program improvement opportunities for the Peak Reduction Program. The results of that analysis include the following potential improvements:.

- The Company will increase targeted customer outreach, using customer demographic attributes, to reach potential program participants. The Company will analyze market segmentation data to identify those customer segments that are likely to have central A/C and, based on their demographic profile, would be more likely to participate in the Peak Reduction Program. This will also include an increased effort to target market the program to qualifying lower-income customers.

- Beginning in 2018, the Company is working with a new program implementer to improve the overall marketing effort and to foster relationships with local Heating Ventilating and Air Conditioning (HVAC) dealers. The Company anticipates that engaging local HVAC dealers, a strategy that hasn't been employed in the previous program years, will provide a face-to-face marketing opportunity while the dealer is at the customer's home on other business. The Company believes this strategy will help improve customer perception of the program, alleviate any customer concerns about a load control switch installation on their A/C unit, and boost overall program participation. The new program implementation contractor plans to hold Lunch & Learn meetings, or similar meetings, to engage these contractors in the program, hire them as load control switch installers, and train them on proper switch installation procedures.
- The Company will investigate the feasibility of offering a nominal "bounty" to participating contractors to market the program directly to customers and enroll the customer in the program on the spot. This could facilitate same day switch installation service.
- The Company will increase efforts to cross market the Peak Reduction Program with other energy efficiency programs offered by the Company. This will include training other program implementation contractors, working on behalf of the Company with other energy efficiency programs, on the Peak Reduction Program, how it works, and the benefits it can provide to customers.
- As part of the new program filing, the program will be offering participating customers a check at the end of the season instead of monthly bill credits. This change will both reduce labor costs, provide a more timely response to program participants, and improve customer satisfaction. Every customer who participates for the full summer cycle of five months will receive a check for $40.00 for each controlled unit in lieu of the former monthly bill credit strategy.
- The Company will investigate the feasibility of marketing the Peak Reduction Program to customers that are located on heavily loaded distribution circuits. This could help offset demand when loading is high on those circuits and possibly delay needed near-term distribution investments.
- Although the program's main purpose is to reduce demand, it can also be invoked when market prices are high. The Company will investigate the feasibility of cycling A/C and Heat Pump units during a few days during the summer season when real time energy prices on the PJM system spike.

7.3.7 Conclusions and Recommendations

The following conclusions are based on the impact and process evaluation activities conducted for the 2017 program evaluation:

- The program operated five load control events this year as well as several test events. All of the previous issues with the switches have been resolved. In addition, the implementer is

continuing to avoid those parts of the state that are not able to receive these signals, thus minimizing this problem going forward.

- The DLC program continues to increase its program participation rates, however it is still lower than the original goal. The Company staff worked with the implementer to make some refinements in program marketing and outreach, including using the Energy Auditors as lead generators for the program.
- Overall, program participants were satisfied with the program and few noted dissatisfaction. Of note is the finding that 95% of respondents were satisfied with information provided about the program and 88% were satisfied with the application process. Dissatisfaction was greatest with the process for scheduling the equipment installation – 11% of participants were dissatisfied with this aspect of the program. The most often mentioned issue was the time it took to get the equipment installed.
- The planned adjustments to the program participation goal, along with an increased focused on customer targeting and outreach, should increase overall participation rates. In addition, the new program implementer should continue to foster relationships with HVAC dealers as a way to further increase overall program participation.

8 Cost Effectiveness Evaluation

The following cost effectiveness tests were performed for each program: Total Resource Cost (TRC) test, Program Administrator Cost Test (PACT), Participant Cost Test (PCT), and Ratepayer Impact Measure (RIM) test. A score above one signifies that, from the perspective of the test, the program benefits were greater than the program costs. The benefits and costs associated with each test are defined in Table 8-1.

Table 8-1 Summary of Benefits and Costs Included in each Cost Effectiveness Test

Variable	*Definition*	*PCT*		*PACT*		*RIM*		*TRC*	
		Benefit	*Cost*	*Benefit*	*Cost*	*Benefit*	*Cost*	*Benefit*	*Cost*
Incentives	Incentives paid to customers.	✓			✓		✓		
Program Installation Costs	Installation costs paid by program.				✓		✓		✓
Bill Savings / Lost Revenue	Reduction in electricity costs faced by customers as a result of implementation of program measures. Equal to revenue lost to the utility.	✓					✓		
Avoided Energy Costs	Energy-related costs avoided by utility.			✓		✓		✓	
Avoided Capacity Costs	Capacity-related costs avoided by utility, including T&D.			✓		✓		✓	
Incremental Costs	Incremental costs associated with measure implementation, as compared with what would have been done in absence of program.		✓						✓
Program Overhead Costs	Program costs other than incentive or installation costs.				✓		✓		✓

Table 8-2 through Table 8-7 summarize key financial benefit and cost inputs for the various tests along as well as the test results for each residential program.

Table 8-2 Efficient Products Program Cost Test Inputs and Results

Variable	PCT		PACT		RIM		TRC	
	Benefit	Cost	Benefit	Cost	Benefit	Cost	Benefit	Cost
Incentives	$ 438,999			$ 438,999		$ 438,999		
Program Installation Costs				$ -		$ -		$ -
Bill Savings (NPV)	$ 2,137,611							
Lost Revenue (NPV)						$ 2,137,611		
Avoided Energy Costs (NPV)			$ 792,044		$ 792,044		$ 792,044	
Avoided Capacity Costs (NPV)			$ 295,820		$ 295,820		$ 295,820	
Avoided T&D Costs (NPV)			$ 52,636		$ 52,636		$ 52,636	
Incremental Costs		$ 436,770						$ 436,770
Program Overhead Costs				$ 585,077		$ 585,077		$ 585,077
Total Benefits	$ 2,576,610		$ 1,140,500		$ 1,140,500		$ 1,140,500	
Total Costs	$ 436,770		$ 1,024,076		$ 3,161,687		$ 1,021,847	
Test Score	5.90		1.11		0.36		1.12	

Table 8-3 Residential Home Performance Program Cost Test Inputs and Results

Variable	PCT		PACT		RIM		TRC	
	Benefit	Cost	Benefit	Cost	Benefit	Cost	Benefit	Cost
Incentives	$ 612,952			$ 612,952		$ 612,952		
Program Installation Costs				$ 120,900		$ 120,900		$ 120,900
Bill Savings (NPV)	$ 1,607,708							
Lost Revenue (NPV)						$ 1,607,708		
Avoided Energy Costs (NPV)			$ 686,731		$ 686,731		$ 686,731	
Avoided Capacity Costs (NPV)			$ 167,786		$ 167,786		$ 167,786	
Avoided T&D Costs (NPV)			$ 37,570		$ 37,570		$ 37,570	
Incremental Costs		$ 9,620						$ 9,620
Program Overhead Costs				$ 696,600		$ 696,600		$ 696,600
Total Benefits	$ 2,220,660		$ 892,087		$ 892,087		$ 892,087	
Total Costs	$ 9,620		$ 1,430,452		$ 3,038,160		$ 827,120	
Test Score	230.84		0.62		0.29		1.08	

Table 8-4 Low-Income Weatherization Program Cost Test Inputs and Results

Variable	PCT		PACT		RIM		TRC	
	Benefit	Cost	Benefit	Cost	Benefit	Cost	Benefit	Cost
Incentives	$ -			$ -		$ -		
Program Installation Costs				$ 799,542		$ 799,542		$ 799,542
Bill Savings (NPV)	$ 908,760							
Lost Revenue (NPV)						$ 908,760		
Avoided Energy Costs (NPV)			$ 424,514		$ 424,514		$ 424,514	
Avoided Capacity Costs (NPV)			$ 117,862		$ 117,862		$ 117,862	
Avoided T&D Costs (NPV)			$ -		$ -		$ -	
Incremental Costs		$ -						$ -
Program Overhead Costs				$ 249,002		$ 249,002		$ 249,002
Total Benefits	$ 908,760		$ 542,376		$ 542,376		$ 542,376	
Total Costs	$ -		$ 1,048,544		$ 1,957,304		$ 1,048,544	
Test Score	N/A		0.52		0.28		0.52	

Table 8-5 Appliance Recycling Program Cost Test Inputs and Results

Variable	PCT		PACT		RIM		TRC	
	Benefit	Cost	Benefit	Cost	Benefit	Cost	Benefit	Cost
Incentives	$ 52,328			$ 52,328		$ 52,328		
Program Installation Costs				$ 139,340		$ 139,340		$ 139,340
Bill Savings (NPV)	$ 348,007							
Lost Revenue (NPV)						$ 348,007		
Avoided Energy Costs (NPV)			$ 135,394		$ 135,394		$ 135,394	
Avoided Capacity Costs (NPV)			$ 35,742		$ 35,742		$ 35,742	
Avoided T&D Costs (NPV)			$ 8,250		$ 8,250		$ 8,250	
Incremental Costs		$ 33,037						$ 33,037
Program Overhead Costs				$ 135,503		$ 135,503		$ 135,503
Total Benefits	$ 400,335		$ 179,386		$ 179,386		$ 179,386	
Total Costs	$ 33,037		$ 327,171		$ 675,178		$ 307,880	
Test Score	12.12		0.55		0.27		0.58	

Table 8-6 ENERGY STAR Manufactured Housing Cost Test Inputs and Results

Variable	PCT		PACT		RIM		TRC	
	Benefit	Cost	Benefit	Cost	Benefit	Cost	Benefit	Cost
Incentives	$ 32,850			$ 32,850		$ 32,850		
Program Installation Costs				$ -		$ -		$ -
Bill Savings (NPV)	$ 165,440							
Lost Revenue (NPV)						$ 165,440		
Avoided Energy Costs (NPV)			$ 79,512		$ 79,512		$ 79,512	
Avoided Capacity Costs (NPV)			$ 8,974		$ 8,974		$ 8,974	
Avoided T&D Costs (NPV)			$ 1,566		$ 1,566		$ 1,566	
Incremental Costs		$ 58,120						$ 58,120
Program Overhead Costs				$ 31,945		$ 31,945		$ 31,945
Total Benefits	$ 198,290		$ 90,052		$ 90,052		$ 90,052	
Total Costs	$ 58,120		$ 64,795		$ 230,235		$ 90,065	
Test Score	3.41		1.39		0.39		1.00	

Table 8-7 Residential Peak Reduction Program Cost Test Inputs and Results

Variable	PCT		PACT		RIM		TRC	
	Benefit	Cost	Benefit	Cost	Benefit	Cost	Benefit	Cost
Incentives	$ 141,346			$ 141,346		$ 141,346		
Program Installation Costs				$ -		$ -		$ -
Bill Savings (NPV)	$ 30,346							
Lost Revenue (NPV)						$ 30,346		
Avoided Energy Costs (NPV)			$ 12,546		$ 12,546		$ 12,546	
Avoided Capacity Costs (NPV)			$ 2,288,712		$ 2,288,712		$ 2,288,712	
Avoided T&D Costs (NPV)			$ 606,638		$ 606,638		$ 606,638	
Incremental Costs		$ -						$ -
Program Overhead Costs				$ 773,692		$ 773,692		$ 773,692
Total Benefits	$ 171,692		$ 2,907,896		$ 2,907,896		$ 2,907,896	
Total Costs	$ -		$ 915,038		$ 945,384		$ 773,692	
Test Score	N/A		3.18		3.08		3.76	